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TRANSACTIONS OF THE

SECTION ON

Orthopedic Surgery

of the
American Medical Association
at the Sixty-Eighth Annual
Session, held at New York
City, June 5 to 8, 1917

AMERICAN MEDICAL ASSOCIATION PRESS
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LIST OF OFFICERS

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1912-13	Chairman, Newton M. Shaffer, New York. Secretary, John Ridlon, Chicago.
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PROCEEDINGS OF THE SECTION

WEDNESDAY, JUNE 6—MORNING

The meeting was called to order by the chairman, Dr. Edwin W. Ryerson, Chicago, at 9:30 a. m. Dr. Ryerson read the chairman's address entitled, "The Care of Cripples as a Problem for Each Individual State." No discussion.

Dr. Wallace Blanchard, Chicago, read a paper on "Treated and Untreated Osteochondritis of the Hip." Discussed by Drs. John Joseph Nutt, New York; Percy W. Roberts, New York; Frederick J. Gaenslen, Milwaukee, Wis.; Samuel C. Baldwin, Salt Lake City; James W. Sever, Boston; Emil S. Geist, Minneapolis, and Wallace Blanchard, Chicago.

Dr. John Joseph Nutt, New York, read a paper on "Neurotization of Paralyzed Muscle: A Clinical and Laboratory Study," with a lantern demonstration by Dr. Alexander Fraser, New York. Discussed by Drs. Arthur Steindler, Iowa City, Iowa; Walter Truslow, Brooklyn; Carl H. Bucholz, Boston; Henry Keller, New York; James W. Sever, Boston; Reginald H. Sayre, New York; H. W. Frauenthal, New York; W. C. Campbell, Memphis, Tenn., and John Joseph Nutt, New York.

Dr. Carl H. Bucholz, Boston, read a paper on "The Lame and Stiff Shoulder." Discussed by Drs. Walter Truslow, Brooklyn; Walter M. Brickner, New York; Wallace Blanchard, Chicago; Melvin S. Henderson, Rochester Minn.; E. D. Oppenheimer, New York; R. O. Meisenbach, Buffalo, and Carl H. Bucholz, Boston.

Dr. Henry B. Thomas, Chicago, read a paper on "Arthritis and Foreign Protein." Discussed by Drs. Walter G. Stern, Cleveland; R. O. Meisenbach, Buffalo, and Henry B. Thomas, Chicago.

Dr. Horace R. Allen, Indianapolis, read a paper on "Fractures." Discussed by Drs. Robert E. Farr, Minneapolis; J. D. Griffith, Kansas City; Edwin W. Ryerson, Chicago; Joseph E. Root, Hartford, Conn.; John Ridlon, Chicago; Albert H. Freiberg, Cincinnati; Henry Keller, New York; Roland Hammond, Providence, R. I.; A. A. Crane, Waterbury, Conn.; Eugene A. McCarthy, Fall River, Mass.; Samuel C. Baldwin, Salt Lake City; Melvin S. Henderson, Rochester, Minn.; J. D. Griffith, Kansas City, Mo.; R. O. Meisenbach, Buffalo, and Horace R. Allen, Indianapolis.

WEDNESDAY, JUNE 6—AFTERNOON

The following papers were presented as a symposium on "Poliomyelitis":

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Dr. Charles Ogilvy, New York: "Study of a Group of One Hundred and Ten Cases of Poliomyelitis, from the Acute Attack to the Present Time."

Dr. E. D. Ebright, Wichita, Kan.: "The Orthopedic Treatment of Acute and Convalescent Poliomyelitis."

Dr. Samuel W. Boorstein, New York: "The Treatment of Anterior Poliomyelitis at Fordham Hospital."

These three papers were discussed by Drs. Charlton Wallace, New York; Walter Truslow, Brooklyn; Henry B. Thomas, Chicago; Willis C. Campbell, Memphis, Tenn.; J. D. Griffith, Kansas City, Mo.; Walter G. Stern, Cleveland; J. H. Eugene Rosamond, Memphis, Tenn.; Peter Bassoe, Chicago; Charles Ogilvy, New York; E. D. Ebright, Wichita, Kan.. and Samuel W. Boorstein, New York.

Dr. Russell A. Hibbs, New York, read a paper on "The Treatment of Spinal Deformities Caused by Infantile Paralysis," with lantern slides. Discussed by Drs. Emil S. Geist, Minneapolis; Fred J. Fassett, Seattle; John Ridlon, Chicago; Horace R. Allen, Indianapolis; Albert H. Freiberg, Cincinnati; E. D. Ebright, Wichita, Kan.; James W. Sever, Boston; Walter Truslow, Brooklyn, and Russell A. Hibbs, New York.

Dr. Michael Hoke, Atlanta, Ga., read a paper on "The Correction of Skeletal Defects of the Lower Extremities Resulting from Poliomyelitis," with lantern demonstration and moving pictures. Discussed by Drs. Charles LeRoy Lowman, Los Angeles; J. D. Griffith, Kansas City, Mo.; Walter Truslow, Brooklyn; Russell A. Hibbs, New York, and Michael Hoke, Atlanta, Ga.

With the consent of the section, the chairman appointed Dr. Charlton Wallace, New York, to act as vice chairman in the place of Dr. Robert B. Osgood, who was absent in Europe; and Drs. Charlton Wallace and Charles G. Stern, Cleveland, in the places on the Executive Committee made vacant by the absence of Drs. Nathaniel Allison, St. Louis, and Leonard W. Ely, San Francisco.

Thursday, June 7—Morning

Dr. Frank E. Peckman, Providence, R. I., read a paper on "The Treatment of Scoliosis." Discussed by Drs. Albert H. Freiberg, Cincinnati; Royal Whitman, New York; E. H. Arnold, New Haven, Conn.; Virgil P. Gibney, New York; Samuel Kleinberg, New York; Frank E. Peckham, Providence, R. I., and James W. Sever, Boston.

Robert Jones of England was nominated and recommended to the House of Delegates as an Honorary Fellow of the American Medical Association. [Duly elected.]

Dr. Royal Whitman, New York, read a paper on "Operative Orthopedics." Discussed by Drs. Samuel Kleinberg, New

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York; Edwin W. Ryerson, Chicago; Melvin S. Henderson, Rochester, Minn.; Henry Keller, New York; Royal Whitman, New York, and Albert H. Freiberg, Cincinnati.

Drs. Robert B. Osgood and Edward C. Bull, Boston, presented a paper on "The Operative Treatment of Tuberculosis of the Knee Joint in Adults." Discussed by Drs. M. S. Henderson, Rochester, Minn.; John Ridlon, Chicago; Mark H. Rogers, Boston; James A. O'Reilly, St. Louis; Henry Keller, New York; Arthur Steindler, Iowa City, Iowa; E. H. Arnold, New Haven; F. J. Gaenslen, Milwaukee, Wis.; Edwin W. Ryerson, Chicago; John Ridlon, Chicago; John Dunlop, Washington, D. C., and Edward C. Bull, Boston.

Thursday, June 7—Afternoon

The following officers were elected: chairman, Dr. Albert H. Freiberg, Cincinnati; vice chairman, Dr. Fred. J. Fassett, Seattle; secretary, Dr. Henry B. Thomas, Chicago; delegate, Dr. John Ridlon, Chicago; alternate, Dr. J. D. Griffith, Kansas City, Mo.

Report of the Tuberculosis Committee was called for. In the absence of the chairman, Dr. Leonard W. Ely, San Francisco, one of the members of the committee, Dr. James A. O'Reilly, St. Louis, made a motion that the committee be abolished. The motion was seconded and carried.

Dr. Russell A. Hibbs, New York, in the absence of the chairman of the Preparedness Committee, Dr. Joel E. Goldthwait, Boston, read the report of the committee, together with an attached list of equipment. On motion, duly seconded, the report was accepted as read. [The report will be found in the Transactions.]

A motion was made that the same committee, already appointed from the American Orthopedic Association, be made also a committee of the Section on Orthopedic Surgery of the American Medical Association, for the purpose of taking up with the government and its various officials the details of orthopedic preparedness. Of this committee Dr. Joel E. Goldthwait, Boston, was chairman. The motion was seconded and carried. [Not transmitted to the House of Delegates.]

Dr. R. O. Meisenbach, Buffalo, offered the following resolution:

Whereas, The experience of the Canadian authorities has been that many of the soldiers have been completely disabled owing to various foot conditions that with special supervision at the beginning might have been prevented; and

Whereas, The foregoing has been forcefully brought to our attention; therefore

Resolved, That it is the sense of the Section on Orthopedic Surgery of the American Medical Association that the attention of the proper authorities should be called to the fact, and the possibility of

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avoiding this difficulty by appointing an orthopedic surgeon on the exemption boards that are now being formed.

This resolution was adopted. [Not transmitted to the House of Delegates.]

Dr. Henry Ling Taylor, New York, made a motion that the attention of the Preparedness Committee be called to the fact that the soldiers, particularly in training camps, do not have long enough hours of sleep, in consideration of the strenuous work that they are called on to perform. The motion was seconded and carried. [Not transmitted to the House of Delegates.]

Drs. William Sharpe and Benjamin P. Farrell, New York, presented a paper entitled "A Further Report of the First Sixty-Five Cases of Cranial Decompression for Selected Cases of Spastic Paralysis Due to Hemorrhage." Discussed by Drs. Fred J. Fassett, Seattle, and William Sharpe, New York.

Dr. James W. Sever, Boston, read a paper on "The Results of the Treatment of Obstetric Paralysis." Discussed by Drs. John Dunlop, Washington; A. S. Taylor, New York; J. A. Nutter, Montreal; John J. Nutt, New York, and James W. Sever, Boston.

Dr. Walter M. Brickner, New York, read a paper on "Pain in the Arm: Subdeltoid (Subacromial) Bursitis," illustrated by slides and moving pictures. Discussed by Drs. Eli Moschcowitz, New York (lantern slides); Arthur H. Bogart, Brooklyn; Fred J. Fassett, Seattle; James A. O'Reilly, St. Louis; Milton G. Wasch, Brooklyn; W. C. Campbell, Memphis, Tenn.; Heinrich Wolff, New York; John Dunlop, Washington, D. C., and Walter M. Brickner, New York.

Dr. Frederick J. Gaenslen, Milwaukee, Wis., read a paper on "Simplified Technic of Laminectomy." Discussed by Dr. Edwin W. Ryerson, Chicago.

Drs. Henry Ling Taylor and George Barrie, New York, presented a paper on "Juxta-Articular Bone Lesions of the Hip." Discussed by Drs. E. D. Oppenheimer, New York; Arthur Steindler, Iowa City, Iowa; Henry Ling Taylor, New York, and George Barrie, New York.

Friday, June 8—Morning

A joint meeting was held with the Section on Nervous and Mental Diseases and the Section on Diseases of Children.

The meeting was called to order at 9:10 by Dr. Bernard Sachs, chairman of the Section on Nervous and Mental Diseases.

Dr. T. C. McCleave, Oakland, Calif., made a motion that the secretary of his section be requested to inform the secretary of the American Medical Association that it was the wish of the sections that hereafter no important action affect-

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ing the sections be taken by the Association without first sending notice to the sections that such action was contemplated. The motion was seconded and carried.

The following papers were read as a symposium on "Infantile Paralysis":

Dr. George Draper, New York: "Early Diagnosis and Specific Treatment of Poliomyelitis."

Dr. Charles Herrman, New York: "Contagiousness of Acute Poliomyelitis."

Dr. Haven Emerson of the Department of Health of New York City was then asked to speak about the epidemic of the disease there last summer, after which the following papers of the symposium were read:

Dr. Frederick Tilney, New York: "Recent Additions to Our Knowledge of Poliomyelitis."

Dr. LaSalle Archambault, Albany, N. Y.: "The Hematogenous Invasion of the Cerebrospinal Axis in Poliomyelitis."

Dr. Henry L. K. Shaw, Albany, N. Y.: "Results of the Present Epidemic of Infantile Paralysis."

Dr. Robert W. Lovett, Boston: "Treatment of Infantile Paralysis, with Especial Reference to a Study of the New York State Cases."

These papers were discussed by Drs. Haven Emerson, New York; Charles L. Dana, New York; Herman Schwarz, New York; E. C. Rosenow, Rochester, Minn.; Reginald H. Sayre, New York; Horace Greeley, Brooklyn; William C. Hager, Brooklyn; Henry Keller, New York; Alexander Spingarn, Brooklyn; George Draper, New York; Charles Herrman, New York, and LaSalle Archambault, Albany.

After the adjournment of the joint meeting, the Section on Diseases of Children remained.

Dr. T. C. McCleave, Oakland, Calif., made a motion that a vote of thanks be given by the Section on Diseases of Children to Drs. Charles G. Kerley, New York; A. Jacobi, New York, and H. M. McClanahan, Omaha. The motion was seconded, and was carried unanimously.

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THE CARE OF CRIPPLES AS A PROBLEM FOR EACH INDIVIDUAL STATE *

EDWIN W. RYERSON, M.D.

Professor of Orthopedic Surgery, Chicago Policlinic; Assistant Professor of Surgery, Rush Medical College; Orthopedic Surgeon to Children's Memorial Hospital and the Home for Destitute Crippled Children

CHICAGO

In every state of the Union there is a large number of crippled persons who are not receiving proper attention. Many of them have no medical or surgical treatment whatever, and most of them have little opportunity to acquire a good education. Entirely aside from their own mental and physical sufferings, they constitute an enormous economic disadvantage and loss to their families and communities and to the state. It has been clearly demonstrated that most of these persons, by proper treatment, may be restored to a condition of usefulness, and that many of them, by proper education, may become able to earn a fair income.

Why is it, then, that only four of our states have established institutions in which cripples may be treated and educated? Is it because the legislators are unwilling to adopt so good a business proposition and so broad a charity? Or is it because the subject has not been presented with sufficient force and energy? The latter is probably the true reason.

It requires a great deal of hard work to persuade a state legislature to devote any of the state revenue to a new project, and the moving spirits in the enterprise must be prepared for a hard struggle. Minnesota,

* Chairman's address.

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New York, Massachusetts and Nebraska have already established institutions for the care of cripples, and the other states must be induced to follow suit.

Allison, in his chairman's address before this section in 1915, states that in the United States there existed at that time ten hospitals, fourteen convalescent hospitals and thirteen asylum homes exclusively for cripples. This number has not been materially increased in the past two years. Approximately 2,000 patients can be accommodated in these institutions. These 2,000 represent a very small proportion of the cripples in the United States. No accurate figures exist to show the total number in this country, but on the basis of the English and German reports by Beyers and Lange, we must have at least half a million and probably more, the accepted proportion being from 3,000 to 3,500 cripples to the million inhabitants. Allison estimates that about 133,000 of these are under 14 years of age. In considering such figures, it must be remembered that not all of these cripples are in need of state or municipal care. Some of them are well treated and well educated at the expense of their own families; but it is safe to say that they form a considerable minority. Two thousand of the remainder are treated at the four state institutions mentioned above and the thirty-three institutions maintained by private charity; a few hundred more are cared for in the wards of general hospitals, and the rest of them are practically neglected, so far as education and skilled treatment are concerned.

We must, therefore, put our shoulders to the wheel and endeavor to construct a plan which will be comprehensive and practical, and which will appeal to the legislators of the various states. This plan should be worked out on a nonpolitical basis. The medical and the educational staffs should not be subject to removal for purely political reasons.

We should, it seems to me, advocate, in all states where it is possible, an orthopedic institution estab-

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lished and maintained by the state, and under the direction and management of the state university, the university furnishing the medical and surgical staff from its own medical school, and the educational staff from its other departments. This orthopedic institution should be one of the units of a state general hospital, which should be operated on the plan of the Michigan State Hospital at Ann Arbor, to which any resident of the state who is unable to pay for a private physician may go or be sent at the expense of the state.

Such an orthopedic institution should consist of a number of different departments: First, a hospital building of sufficient size, in which operative and mechanical treatment can be carried out for those who need it. Second, a convalescent department, for those less acutely affected, with separate provision for the case of tuberculous bone and joint disease. Third, a permanent home for those cripples who have no home.

It must be remembered that many of the patients in such an institution will have to remain there for years, that the larger proportion of them will be children, and that they must be educated as well as healed. It is in this respect that many institutions are deficient. The vast majority of cripples in this country can be made into useful citizens if they can be properly taught such forms of work as they are capable of performing. Their lives will be infinitely happier and more valuable if they can be trained in the useful arts and industries, and in place of being useless drags on the community, they will become actual producers and providers.

An institution of the kind here outlined should be open to people of all ages. Many of our existing hospitals and homes for cripples accept only children, and when the little patients reach the age of 12 or 14 they are turned out into the world to shift for themselves, whether they are cured or not. We must make it very plain to our legislators that it takes many years to cure

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some of the cases of tuberculous joint disease, for example, and that there are many adults who need just as skilful and prolonged treatment as do the children. If we are to attempt some radical and constructive work in our various states, let us make it as comprehensive and as broad as possible.

The educational lines of the institution can hardly be discussed by a mere surgeon, but it would appear practical to teach the cripples useful trades, such as light manufacturing, shoemaking and cobbling, brush and basket making, sewing, millinery, dressmaking and embroidery, and to find a market for the results of the labor. Some of the patients will undoubtedly be found mentally equipped for higher education, and this could readily be provided.

It is probable that the great international conflict into which we are now plunged will rightly and properly overshadow any great progress in the directions that I have indicated, but we must, after all, build for the future, and we who spend our lives among these unfortunates should be the ones to turn the spotlight of publicity on their helplessness and their crying needs.

122 South Michigan Avenue.

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TREATED AND UNTREATED OSTEO-CHONDRITIS JUVENILIS OF THE HIP

WALLACE BLANCHARD, M.D.
Fellow of the American College of Surgeons
CHICAGO

Perthes' disease, or osteochondritis juvenilis of the hip, results in far more extensive bone atrophy than has been supposed. The bone atrophy and rarefication are so extensive that they have changed our previous conception of the pathology of the disease.

Up to the present time, the only joint and bone changes recognized in Perthes' disease have been a partial or total destruction of the head of the femur with a stumping of the neck, together with a thinning of the femoral shaft. Most authors have agreed with the unsustained suggestion, made by Freiberg[1] at the last session of this Association, that the disease is caused by tonsillitis or some other local infection. Experiments have been made on animals by Allison[2] to determine what influence a slight injury or displacement to the epiphysis might have on the hip, and his results were negative.

Since I desired to make a comparative study of diseased and normal hips, I had roentgenograms taken of cases of Perthes' disease, to include all of the pelvis as well as both the femoral shafts on single large plates. In these comprehensive pictures, I soon discovered decreased bone density and some atrophy of the pelvis on the diseased side in the acute cases.

1. Freiberg, A. H.: The Evolution of Osteochondritis Deformans Coxae Juvenilis, The Journal A. M. A., Aug. 26, 1916, p. 658.
2. Allison, Nathaniel: Am. Jour. Orthop. Surg., October, 1915.

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The bone atrophy and lessened density are of about the same degree in the ilium, ischium and pubic bone as in the shaft of the femur. The atrophy of the ischium and pubic bone usually reduces the obturator foramen to one-half the size of the opposite foramen, as is well shown in Figure 4. On examining roentgenograms of both legs in one picture, it soon became apparent that all the bones of the leg suffered moderate atrophic changes. Decreased density is also seen in all the surrounding muscles and other soft parts.

The shrinking of the head of the femur leaves a vacant space in the acetabulum which shows principally adaptive changes.

Atrophy of bones and muscles is one of the first symptoms, and is as equally constant in the functionally used diseased leg as in the unused diseased leg. The atrophy becomes less as the distance increases from the hip.

Early and continued mechanical treatment that protects the head of the femur from weight-bearing, jar and concussion will usually preserve the head in its rounded shape; but observation of a number of treated and untreated cases shows that the best available mechanical treatment has little or no effect in either preventing or causing atrophy of the bones and muscles of the leg of the diseased side.

I have not been able to locate a tonsillar or other source of infection in a single case.

The moderate but extensive atrophy and decreased density of bone and adjacent tissues precludes the possibility of the disease being due to a circumscribed joint infection or an epiphyseal injury. The disease is undoubtedly trophic in character and is probably caused by an extensively disturbed blood circulation that impairs nutrition from a median pelvic line to the foot.

It is unfortunate that this rather recently discovered disease of the hip joint has been differentiated from

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tuberculous hip disease, with which it has been so long confused, if the treatment is to be neglected because it runs a milder course and with much less resulting deformity.

Patients who have had Perthes' disease which has been diagnosed as tuberculous hip disease, and who have promptly received the best mechanical and general treatment usually accorded to tuberculous hips, have invariably made the best possible recoveries.

The neglected and untreated cases of Perthes' disease after one or two years show the heads of the femurs to be nearly destroyed, with the necks stunted, and in coxa vara or coxa valga positions. Abduction is partly lost, and movements of the hips in other directions are slightly limited. The legs are from 1 to 3 cm. short, and the patients walk with a limp.

The friction and concussion of weight-bearing on softened bone cause the erosion of the head and the stunting of the neck of the femur. The disease is self-limited. The extensive bone atrophy, together with the obliteration of the head of the femur, runs its course in about one year, and this is followed by a longer period of bone hardening and rebuilding. One proof of this limited course is that if the head of the femur is protected from the outset of the disease by adequate mechanical treatment so that it retains its rounded shape for two years, it again becomes hard, firm and self-protecting.

Roentgenograms show a decreased density of bone in the first year of the disease, and during the second and third years the deepened shadows indicate that the diseased bones have become harder and more dense than normal bones. This hardening resembles the eburnation of soft bones after rickets, in which they frequently become as hard and firm in a child of 5 years as in a man of 25.

There is perhaps no destructive joint lesion that is quite as amenable to treatment as Perthes' disease. The

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promptness with which the head of the femur rebuilds under mechanical protection is quite surprising.

If an adequate protective mechanical treatment is commenced even late in the course of the disease, when the head of the femur has been destroyed, and the treatment is then continued for a year or two, the head of the femur will regenerate to nearly its full rounded shape, in the same manner that the head of the femur rebuilds for several years after the reduction of a congenital hip dislocation, with the result that the ultimate shortening will be lessened fully a half. The limp is relieved in proportion to the regeneration of the head of the femur.

This rebuilding is a further proof that Perthes' disease is not an infective epiphysitis, since after the head of the femur has been destroyed by an epiphysitis, it does not regenerate.

Roentgenograms of untreated cases of Perthes' disease, taken from seven to eight years after the disease has run its course leaving only remnants of a head or a stunted neck, show that unaided Nature has been partly successful in rebuilding the head to its normal shape.

In Perthes' disease, lengthening of the leg rarely happens, but I have one case to report.

A. H., a boy, aged 6 years, has had pain in his hip, and walked for one year with the left leg abducted. The roentgenogram (Fig. 5) shows the usual atrophic changes. The abduction leverage on the softened neck and shaft of the femur during the one year of acute disease has straightened the normal outcurve of the shaft and elevated the neck about 35 degrees, causing a 4 cm. lengthening of the left leg. The abduction protected the head of the femur, which shows only atrophic changes. The hardening stage is somewhat advanced, and nothing but an osteotomy at the neck can restore the normal relations. The boy walks with a limp to the right.

In marked contrast to the depression seen in tuberculous, hip disease, patients with Perthes' disease usually retain the irrepressible spirits of healthy childhood.

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Fig. 1 (Case 1).—Atrophy and greatly reduced density of the pelvic bones, femur and muscles of the diseased side in acute Perthes' disease in a boy, aged 5 years.

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Fig. 2 (Case 2).—Reduction of the head of the femur to a small pyramid of bone in E. M., a girl, aged 8, who had had Perthes' disease for one year; the leg is 2 cm. short; the patient walks with a limp.

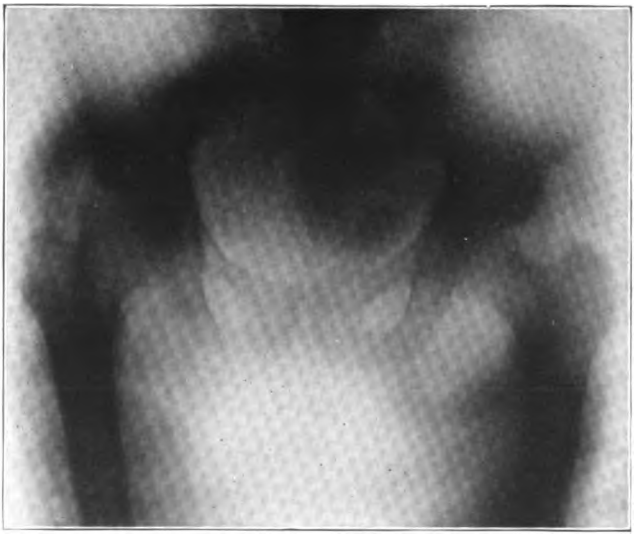

Fig. 3 (Case 2).—Regenerated head of the femur in E. M. at the age of 15 years; the patient had mechanical treatment during the second year of the disease, and walks without a limp.

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Fig. 4 (Case 3).—Head of the femur, in which only two small buttons are left, in an untreated case of Perthes' disease in a girl, aged 8 years; the leg is 2.5 cm. short, and the patient walks with a limp.

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Fig. 5 (Case 4).—Lengthening of the leg in Perthes' disease, a rare resulting deformity, in a boy, aged 6.

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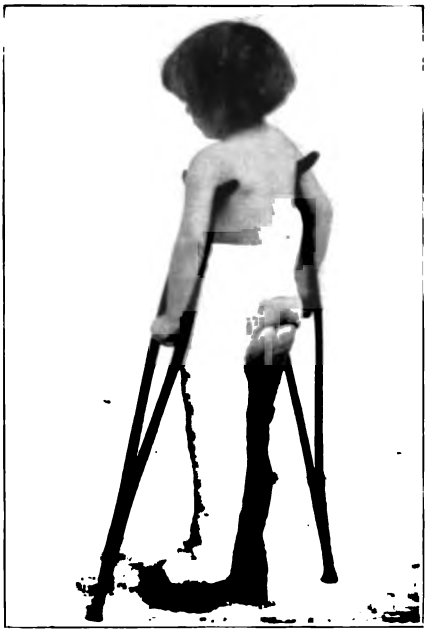

Fig. 6 (Case 5).—A girl, aged 5 years, with Perthes' disease, in a plaster-of-Paris spica, with high shoe and crutches.

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Fig. 7 (Case 6).—A boy, aged 5 years, with Perthes' disease, in a strap iron hip splint, with high shoe and crutches.

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In going over thirty years of hospital and private histories of tuberculous hip disease, I have been able to cull out over forty cases of undoubted Perthes' disease in which the patients were treated as having tuberculous hips and discharged cured with results too suspiciously good to have been obtained in tuberculous cases. In a number of these cases, the roentgenograms confirm the late diagnosis of Perthes' disease. It is a consolation to know that even if the diagnosis was incorrect the patient received the best possible treatment.

The condition is not likely to be confused with any other than tuberculous hip disease. The patient is usually from 4 to 10 years of age, walks with a slight limp, and complains of occasional pain. There is always some atrophy of the thigh and less of the leg. Abduction is limited, but movements in all other directions are free. These symptoms closely resemble the symptoms of an insidiously advancing tuberculosis of the hip joint, but the roentgenogram will usually decide. If it is too early for pathologic conditions to show decisively in the roentgenogram, one should be taken a month or several months later, but the mechanical treatment should be begun immediately, since in either condition the treatment will be the same, and the treatment cannot be commenced too early. With the hip joint well protected, constant exercise in the open air and a liberal raw food diet seem to be of greatest service in the treatment of Perthes' disease.

Every orthopedic surgeon is familiar with the plaster-of-Paris spica and with a variety of hip splints that afford good protection to the head of the femur, and I present the accompanying pictures of patients with Perthes' disease, the one in a plaster-of-Paris spica and the other in my strap iron hip splint with high shoe and crutches, only to emphasize the necessity of very complete protection to the hip joint in order to get the best possible ultimate results.

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CONCLUSIONS

1. Osteochondritis deformans juvenilis seems to be a nutritional disease of the bones and muscles of the hip and leg.

2. The femoral head that continues in functional use during the acute stage of the disease becomes obliterated wholly or in part by the attrition of weight-bearing on softened bone.

3. The head of the femur that is mechanically protected throughout the acute stage of the disease suffers only the same atrophic changes as the adjacent bones.

4. In convalescence, the destroyed head redevelops rapidly under mechanical protection, and redevelops more slowly and less perfectly without protection.

5. The disease progresses with one year of bone and muscle atrophy and lessened density followed by several years of increasing density and redevelopment.

6. The bone hardening resembles the eburnation after rickets.

7. From the foregoing facts it may be inferred that this disease of growing bone is nutritional character, and is due to a blood circulation that is disturbed from a median pelvic line to the foot, and that the head and neck of the femur are only incidentally affected.

8. The question of etiology remains of chief interest.

15 East Washington Street.

ABSTRACT OF DISCUSSION

Dr. John Joseph Nutt, New York: Although the author of the paper said that the etiologic factors are of the most interest, it seems to me that it is of more practical interest to decide on the best method of treatment. A great many advocate treating these patients not at all; some advocate treating them slightly; and some advocate treating them much more thoroughly. If we treat them too slightly and neglect them, I think we will have worse results than by making mistakes in diagnosis and treating them as tuberculous hips.

One point that I have never thought of before is that as the head becomes flattened and lessened, the line formed by the lower edge of the shadow of the neck does not quite

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fall in line with the line showing the upper border of the obturator foramen.

Dr. Percy W. Roberts, New York: I merely wish to ask Dr. Blanchard what, in his experience, have been the acute symptoms; or, perhaps, to put it differently, in what proportion of cases has he seen such symptoms as pain and spasm?

Dr. Frederick J. Gaenslen, Milwaukee, Wis.: I want to emphasize what I consider a very important point made by Dr. Blanchard. The tendency has been to let these patients go on about as they pleased, feeling that ultimate recovery, with but slight deformity, would result. I think he has sounded an important note of warning in advising against this, and I endorse his recommendation of judicious supportive treatment.

I wonder whether Dr. Blanchard did not make a mistake in referring to Dr. Freiberg as having written a paper on the infectious origin of osteochondritis. I think it was Dr. Kidner.

I became much interested in this condition when Calvé, in 1912, at Berc-sur-mer, showed me some cases of what we now know as Perthes' disease, which he described as pseudocoxalgia. When I visited Perthes at Tübingen in the same summer he showed me examples of the same group of cases. I told him at that time that it corresponded exactly to the type of cases that Calvé had shown me. He was much interested, and I let him have the reprint that Calvé had given me. At first he thought the cases were not the same; but later changed his opinion, and regarded them as identical. If we want to add another name to the already hyphenated appellation of the disease, I think the name of Calvé should find a place in it.

Dr. Samuel C. Baldwin, Salt Lake City: I did not hear Dr. Blanchard say anything about the symptoms, or whether in his cases he found much pain. Last year, at the clinical meeting of the American Orthopedic Association at Philadelphia, Dr. James K. Young showed roentgenograms of several cases in which there had been a great deal of destruction of the bone. I have had one very interesting case recently, which illustrated what Dr. Blanchard has said about these cases having been treated for tuberculous hip disease, years back, when they were really cases of Perthes' disease.

About fifteen years ago, I had a boy whom I treated for hip disease. Last summer his sister was brought to me with a condition that looked exactly like Perthes' disease of the hip, but it was in the second metatarsal bone. When I saw the girl first she was about 16 years old. There was no swelling or tenderness, and she had had practically no pain in the joint. If she walks a great deal and gets very tired the joint will sometimes pain her just a little. The head of the second metatarsal bone looks exactly like the head of

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the femur in a case of Perthes' disease. About fifteen years ago, as I have said, I treated her brother for hip-joint disease and he got well a great deal more rapidly than these cases usually do. He is well now, with very little limp, and I have wondered whether this was a case of hip disease or what we now know as Perthes' disease. His mother told me that he had been at work for a number of years and had a very slight limp. I do not know whether this condition has been described in any other bones than the head of the femur or not, but in the case of the sister I was impressed by the shortening of the toe, such as we get in the head of the femur in Perthes' disease, and by the lack of other symptoms.

Dr. James W. Sever, Boston: I should like to make a plea for the calling of this condition Legg's disease rather than Perthes' disease or Legg-Perthes' disease.

In the routine treatment of the cases at the Children's Hospital, Boston, use is made of the abduction splint; or what we used to employ is the old Taylor splint, and what we use now is the abduction splint, just as we do in tuberculosis of the hip. The patients are guarded to prevent walking on the affected limb, which is kept abducted and on a certain amount of traction. A plaster-of-Paris spica is not used, and the patients go on crutches. They do not get much deformity in the neck of the femur. They do, however, get some flattening and overgrowth of the edges of the epiphysis; and they recover with some limp, but very little deformity.

Dr. Emil S. Geist, Minneapolis: Regarding the condition of toe deformity, we saw yesterday, at the clinic of Dr. Hibbs, a roentgenogram of that case. The condition has recently been well described by Dr. Freiberg. It bears a relation to osteochondritis of the hip, in that these toe cases are usually the result of injury, and the question arises whether there is a similarity between these two conditions in that regard.

Dr. Wallace Blanchard, Chicago: Many cases of Perthes' disease run a very mild course and remain unrecognized for several years.

I think that there was no mistake in my quotation from Dr. Freiberg. I got the information from the Transactions of the Section on Orthopedic Surgery of the American Medical Association, 1916.

The obturator foramen frequently becomes one-half the normal size at the end of the first year of the disease. It usually becomes gradually smaller until it ultimately diminishes to one-third the size of the opposite foramen.

One gentleman asked whether these patients come to us early. They seldom come early, and many times not until the second or third year of the disease.

Dr. A. T. Legg announced a paper before the American Orthopedic Association at Pittsburgh, in June, but failed to

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appear. In the announcement, he said that he was going to give the histories and descriptions of seventy-five cases of regenerated and flattened heads of femurs, and that twenty-five of these had been regenerations of the head after the reduction of congenital dislocation of the hip. The others he could not account for; and it occurs to me that most of these, and perhaps all, are rebuilt heads after unrecognized Perthes' disease.

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THE STIFF AND LAME SHOULDER

C. HERMANN BUCHOLZ, M.D.
BOSTON

Proper function of the shoulder depends on the intactness of the humeroscapular joint, both clavicular joints, the subacromial bursa and other periarticular structures, and the muscular mechanism. The humeroscapular joint allows a great amount of motion, which, however, is checked to some extent by the acromion, in order to give sufficient stability and strength. Again, a great deal of motion which is checked by the acromion is compensated by the mobility of the scapula, which swings around the clavicular joint and is regulated by the complicated muscular apparatus.

The great frequency of lame and stiff shoulders is easily explained by their complicated apparatus, and by their free exposure to strain and injury. For the latter reason, it is evident that the periarticular structures, especially the subacromial bursa, are much more frequently affected than the humeroscapular joint itself, a fact which the investigations of Küster and Codman have clearly demonstrated. It is particularly through Codman's effort that we have learned to approach certain affections of the shoulder with the knife, and the chances of necropsy have, in turn, helped to give us clearer ideas about the physiology and pathology of the shoulder. In this paper I shall attempt to outline the indications for the treatment, both operative and nonoperative, in those various types of stiff and lame shoulders that come under our observation. The second part contains a description of the conservative method of treating stiff shoulders.

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1. *Acute Subacromial Bursitis.*[1]—These cases are best treated with rest, preferably with the arm held in a sling or supported in the abducted position. This may be done by simply having the arm rest on a table, or, during the night, somewhat elevated and abducted on a pillow. As soon as the most acute symptoms are over, a mild application of hot air and massage will help to relieve the pain and discomfort. Then the patient may begin to use the arm, and special treatment for the recovery of the function is generally unnecessary. There are, however, a number of patients who hold their arm in a certain muscular spasm, instinctively induced by fear of painful motion. In many of these cases, the condition is easily relieved by a few gentle assistive movements in the lying position. We have frequently seen patients who had not dared to move the arm for weeks, and complained of a great deal of pain from any attempt to raise the arm or to put it on the back. In such cases, it is sometimes surprising for the patient as well as the operator to notice the relief from pain and discomfort by a few simple movements gently guided, from the lying position, or by the following simple exercise recommended by Codman: The patient leans over, forward or sideways, and lets his arm hang down perpendicularly with the muscles completely relaxed. Easy swinging motions may be added from that position. Once started in such a way, movements of the arm will be quickly restored, provided there is no serious lesion of the shoulder joint or bursa present.

2. *Subacute or Chronic Adherent Subacromial Bursitis.*—These cases are very frequent. We see at least 100 every year in the medicomechanical department, and many of them represent difficult problems. In the great majority, however, correct exercise, aided by massage and application of hot air, will give good

1. The headings and the indications for treatment in Types 1, 2 and 7 are taken from Codman's classical monograph.

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results, though the treatment often requires a long period. As there is a tendency to hyperirritation, it is advisable to begin with treatment of short duration. The technic will be discussed in detail in the second part. When the adhesions prove to be too firm to be loosened by simple manipulations, forcible breaking up under an anesthetic may become advisable, or it may be necessary to open the bursa. We approve of Codman's advice to do even the forcible manipulations under the careful guidance of the finger after the bursa is opened, as evidently less harm is done in that way. From our experience, however, it must be stated that with advanced technic of the exercise treatment those cases have become quite rare, and forcible manipulation in this type of cases is performed in our clinic but very exceptionally.

3. *Stiff and Lame Shoulders Following Injuries of the Upper Extremity.*—A large percentage of stiff and lame shoulders follows injuries to the shoulder region itself or any other part of the upper extremity. In many of these cases, stiffness could be prevented by proper consideration of functional principles during the first weeks after the injury, principles which have been outlined in detail elsewhere.[2] The stiffness in these cases is caused not so much by adhesions as by retraction of the muscles and the periarticular structures, and from the commonly used method of fixing the injured arm in the adducted and inward rotated position. The retraction is mostly seen in the inward rotator muscles and in the structures in front of the shoulder joint. These retracted tissues generally form a very serious and sometimes insurmountable obstacle to mobilization, and we have seen many cases of this type in which the patients did not regain the function of the shoulder in spite of very persistent and long continued after-treatment. In these cases all depends on the recovery of a certain degree of external rota-

2. Bucholz, C. H.: Manual of Therapeutic Exercise and Massage, and several other publications.

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tion; if this succeeds, the other motions will usually follow.

Operative procedures will hardly help much, and forcible manipulation has not given any single good result in my experience. Moreover, it is dangerous, as we have seen a spiral fracture of the humerus, complicated with paralysis of the musculospiral nerve, in a case in which a forcible attempt at external rotation was made. As elsewhere in the body, following injuries, the scarlike, retracted tissues may become so tight that in an attempt to stretch them the atrophic bone gives way rather than the soft tissues. Any one familiar with the nature of these retractions can not doubt that quick stretching will mean more or less laceration of tissue, and hence renewed injury with all its deleterious consequences. As I have stated above, however, by persistent, frequently repeated stretching manipulations, good success can be obtained, provided the alteration of the tissues has not been too severe.

4. *Infectious Arthritis of the Humeroscapular Joint.*—Previous to the publications of Küster and Codman, cases of painful and stiff shoulders have been generally classified as "arthritis," or as the still frequently used term "omarthritis." We know now that the majority of these cases cannot be considered as arthritis in the strict sense of the word, but as periarthritis or bursitis. The differential diagnosis between the two affections cannot be made in all cases by the clinical examination of the affected part alone, but only with sufficient consideration of the history and other manifestations of the disease. Monarticular arthritis generally leads toward several definite channels in regard to the nature of the affection, such as tuberculosis, gonorrhea, septic infection, osteomyelitis, and a few of rarer occurrence. These types can be ruled out in most cases without great difficulty, though we have seen cases in which only by long observation

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or by opening the joint could the diagnosis be made certain.

In polyarticular arthritis, involvement of one or both shoulders should be primarily considered as true arthritis, although the bursae may be likewise affected, and in the treatment for functional recovery this bursitis may cause more difficulties than the arthritis itself, as I have repeatedly noticed. The indications for functional treatment in arthritis are similar to those outlined under headings 1 and 2, only with sufficient consideration of still greater care and gentleness. That in all these cases etiologic factors are sought for and eliminated if possible is understood, and requires no further discussion at this place.

5. *Tuberculosis of the Shoulder Joint.*—Tuberculosis of the shoulder joint may appear as the proliferative fungous type, or as the degenerative dry type, tuberculosis sicca. The former is generally easily recognized, and with the presence of an abscess or sinuses, there can be no doubt as to the diagnosis; but in the other type the difficulties may be great unless the Roentgen ray shows definite signs of destruction.

Generally, however, the atrophy of the muscles and bones is much more pronounced than in any of the other types. In case of doubt, the general and local reaction by injection of tuberculin should be tested, and no exercise recommended before the diagnosis of tuberculosis has been ruled out definitely. The treatment of tuberculosis of the shoulder joint will not be considered in this paper.

6. *Hypertrophic Ostearthritis.*—Many cases of stiff and lame shoulders are caused by hypertrophic ostearthritis. It must be remembered, however, that very often it is not so much the affection of the shoulder joint proper which causes most of the trouble, but the bony proliferation over the tuberosity, as several observations have undoubtedly shown. Strange to say, this point has found very little attention in the

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literature. The publications on "arthritis deformans of the shoulder joint" which I have read do not mention the proliferations of the tuberosity or their close relation to chronic bursitis. I advise looking for these affections in all elderly persons. Generally they cannot be felt from the outside, and even the Roentgen ray does not always give a distinct idea about their size and location. All that we can make out on the plate is the density of the structure of the tuberosity. Generally there are other signs of osteoarthritis seen on the roentgenogram, such as proliferations at the acromioclavicular joint, the lower edge of the glenoid process, and elsewhere. It lies in the nature of the mechanics of the shoulder articulation that bony proliferations nowhere so retard the function of the arm as those over the tuberosity. The shoulder capsule itself is fairly loose, and needs considerable alteration before the function of the arm is so much handicapped as to be alarming to the patient. The same is true for the acromioclavicular joint; proliferations over the tuberosity, however, represent a much greater danger for the function, because, after having reached a certain size, they will materially narrow the space between humerus and acromion. Moreover, hypertrophic ostearthritis stamps the tissues affected to a much greater susceptibility to traumatic damage. The tuberosity, anyway one of the most frequently injured parts of the body, when inflicted with the changes of ostearthritis, is likely to react much more violently than under normal conditions.

Of still greater importance, however, is the intimate connection of those proliferations over the tuberosity with chronic inflammation of the bursa. We may even say that the amount of pain and discomfort depends more on the consequent bursitis than on the bony proliferations, while the amount of stiffness is the result of both these factors in addition to the condition of the capsule and the other articular and periarticular structures.

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Without discussing the general principles of treatment in these cases, I shall briefly state my opinions in regard to the local treatment. Any evidence of hypertrophic arthritis in a case of stiff and lame shoulder leads us on a very conservative track. We should avoid all irritative measures; applications which in other cases act soothingly may cause irritation in a hypertrophic shoulder. Therefore we give baking of shorter duration than usually, apply massage with less force, and do not use that deep friction over the bursa which is so effective in many other cases. Exercise is used chiefly in form of gentle resistive movements with careful guidance of the finger over the tuberosity.

We have operated in two cases, which are briefly outlined:

Case 1.—A strong and healthy laborer, aged 46, who had injured his left shoulder five years before without lasting symptoms, complained of considerable pain in the same shoulder for one month which, starting after a hard day's work, prevented him from work and often kept him awake at night. At the operation the subacromial bursa was found somewhat inflamed and its walls slightly thickened, but the most conspicuous feature consisted in a number of bony proliferations along the crest of the tuberosity. In abduction and elevation the space between the humerus and acromion was markedly narrowed, and therefore some of the most prominent proliferations were removed from underneath the floor of the bursa. There was no immediate relief from the operation, but the condition improved gradually by baking and massage for several weeks.

Case 2.—A rather feeble and sickly looking man, aged 55, who was run over by a light wagon six months previously, had since that time suffered from pain and stiffness in his shoulder which did not respond to the usual conservative treatment. He had a certain amount of hypertrophic arthritis in this and other joints, as shown by the Roentgen ray. On account of his general poor health, the subacromial bursa was opened under local anesthesia. The bursa was inflamed and slightly thickened, the walls were partially glued together about the edges, and a few soft bands were stretched from the inner to the outer wall. Marked bony proliferations were noticed along the crest of the tuberosity, and in moving the arm it was quite evident that the motion was mostly limited by the bony overgrowth. This was not removed because of the patient's condition, but the soft tissue adhesions were gently loosened and the bands excised. The patient

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was subjectively much relieved, though the function of the shoulder was not much improved.

7. *Chronic Nonadherent Subacromial Bursitis* (*Codman's Type III*).—These cases, which represent approximately 5 or 10 per cent. of all our cases of bursitis, are characterized by a more or less constant pain and soreness, which is most intense in forward elevation with inward rotation, often leading to a spasmodic contraction of the shoulder muscles to avoid painful motion. The basis of these symptoms consists of thickening of the bursae, fringes, bands or other pathologic products which obstruct the tuberosity on its way underneath the acromion. It is obvious that a simultaneous ostearthritis may still increase these symptoms, and in most cases it may not be easy to state definitely which of the symptoms is due to one or the other. However, the roentgenogram, the amount of mobility beyond the horizontal line and ostearthritic manifestations in other joints may allow a certain conclusion.

At any rate, in cases with a definite manifestation of ostearthritis, a certain conservative reservation should prevail, while in the others operative repair may be suggested as the quickest and surest way to recovery, although, as Codman states, many of these cases heal in time without any treatment. Baking and massage may relieve the pain; exercise in any form is contraindicated.

The following cases seem to belong in this class:

Case 3.—A laborer, aged 45, fell from a ladder six months previously, landing on his left shoulder and hip. Since that time he had had pain and discomfort at night and in moving the arm. The motion was almost free except in extreme inward rotation, but there was marked crepitation in abduction, and tenderness over the bursa. At the operation, two bands were found stretched between the inner and the outer walls of the bursa, which was otherwise somewhat inflamed and slightly thickened. The bands were removed and the operation was followed by a quick and perfect recovery.

Case 4.—A farmer, aged 56, who had injured his right arm eight years before, complained that he had had pain at the

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right shoulder, radiating downward to the elbow at night and in moving the arm, for about four years. At the operation, five small villous tabs were found on the posterior wall of the bursa near the crest of the tuberosity. These were removed, and the operation was followed by a perfect recovery within a few weeks.

8. *Lime Salt Deposits at the Subacromial Bursa.*—More has been written of these cases than of all other types of subacromial bursitis, and still a certain dissension of opinions exists in regard to the seat and nature of these deposits and their best method of treatment. In regard to details of this discussion, I refer to the papers of Codman, Brickner, and others and shall but briefly state my own experience. I have studied only four cases of this type, in two of which I have operated. In both cases the deposits were beneath the floor of the bursa, in one, seemingly in the tendon sheath of the supraspinatus, while in the other, that part of the tendon which is nearest to the insertion was perforated like a sieve, the holes being filled with caseous deposits. Both these cases, therefore, support Brickner's statement that the lime salt deposits have their seat in the tendon of the supraspinatus or other tendons or their sheaths. In both cases the deposits have been scraped out as much as possible, but the end-results have been very unsatisfactory, in regard both to pain and to function. This experience has led me to choose a conservative treatment in two other cases in which there has been a perfect, or almost perfect, recovery.

9. *Rupture of the Supraspinatus Tendon and the Roof of the Capsule of the Shoulder Joint.*—Codman has shown that these cases are more frequent than has hitherto been believed, but we are still far from knowing definitely how frequent they are, as their diagnosis is often quite difficult. Risley goes so far as to set a time limit of three months. Careful observation, however, has enabled us to make the diagnosis in one case fairly early. Two patients entered the outpatient clinic on the same day with almost the

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same history, and very similar symptoms. Both reported a severe strain of the shoulder a few weeks previously, disabling the arm completely as far as elevation and abduction were concerned. Both were suspected to have a ruptured supraspinatus, and I treated them with massage and very gentle active-passive movements. In one case the symptoms cleared up within three or four days, and the patient was completely relieved within two weeks, whereas in the other, the lack of action, elevation and abduction persisted, and the pain was not much relieved. In the latter case, therefore, an operation was done which revealed rupture of the supraspinatus tendon.

REPORT OF CASES

CASE 1.—A healthy man, aged 50, injured his left shoulder three months previously. In lifting a heavy harness above his head to a rack, his foot slipped, and he felt something give way in his left shoulder. He managed to lift the harness up on the rack, but afterward could not raise his arm. His left shoulder was sensitive, and showed almost complete absence of active and passive motion. A diagnosis was not made until, after several weeks' treatment, a certain amount of passive motion was restored, but active function did not return along with the passive motion.

An operation was therefore advised; the subdeltoid bursa was opened in the usual way, and after exposure of the subacromial space, it was found that the supraspinatus tendon was torn loose from its insertion for about two thirds of its width. There was also a large hole in the capsule so that the subacromial and the shoulder joint connected through a hole the size of a quarter. The torn ends of the capsule and tendon were sewed down to the tuberosity, and the arm put up in abduction for about five weeks.

Motions of the arm were begun two weeks after the operation, and within six months the patient's shoulder was perfectly restored as to motion and strength.

CASE 2.—A healthy man, aged 60, while pulling on a truck two weeks previously, received a severe pull on the shoulder, and felt something give way. This was followed in two days by another injury to the shoulder, and the patient was forced to stop work on account of the severe pain which radiated down from the shoulder to the outside of the elbow. He said that he had had a certain limitation in motion of the right shoulder for a year, and occasionally little pain. The patient was unable to raise his arm actively, but in stooping over

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could abduct his arms almost to right angle without pain. There was a painful swelling over the right shoulder.

Roentgenoscopy revealed hypertrophic changes about the greater tuberosity, and at the acromioclavicular joint, and a free mass in the latter joint.

On account of these signs, the diagnosis of rupture of the supraspinatus was made, and operation advised. Operation was performed by Dr. R. B. Osgood, using the "saber-cut" incision across the acromion and through the acromioclavicular joint. The roof of the bursa was adherent to the deltoid. The capsule was seen to be ruptured, and the supraspinatus found to be torn off at its attachment to the bone. The tendon and capsule were sutured by silk and kangaroo tendon.

After-treatment was started as in Case 1, but the functional recovery was not quite as satisfactory, probably on account of the marked hypertrophic changes.

Case 3.—A bartender, aged 53, was struck by an automobile five months previously. He was unconscious for a few moments, but thinks that the automobile struck the right shoulder directly. He went to a surgeon, who made a diagnosis of dislocation of the humerus, and replaced it under ether. A Sayre adhesive dressing was applied for five and one-half weeks without change, leaving the whole arm stiff from the shoulder to the fingers. When the patient entered the hospital, therefore, the correct diagnosis was not possible; but when, by persistent treatment with massage and exercise, the passive mobility had been improved to a certain extent, but active abduction still was impossible, the diagnosis became suggestive of a ruptured supraspinatus, and operation was advised.

The clinical picture was complicated by an unreduced dislocation of the acromioclavicular joint, the outer end of the clavicle riding almost over the acromion. The Roentgen ray revealed hypertrophic arthritis with intensive spur formation on many joints, including the acromion, with bony atrophy of the head of the humerus and the glenoid process.

The subdeltoid was opened as in Case 1. There was a very extensive laceration of the supraspinatus and capsule, making a connection between the bursa and joint almost the size of a silver dollar. By the unreduced dislocation of the clavicle, the replacement of which was not attempted, the space was markedly narrowed, and the torn tendon and capsule were markedly retracted, so that only with great difficulty could silk strands be passed through its edges. Even with full abduction, complete apposition seemed hardly possible.

After-treatment was begun in a way similar to the first case, and the patient made a good recovery, though a certain amount of stiffness persisted. Six months after the operation, however, he was able to raise the arm with considerable strength far beyond the horizontal line, and used the arm almost as before.

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THE CONSERVATIVE METHOD

The technic of conservative treatment of shoulder lesions is not so easy as is frequently believed, and from our experience with more than 2,000 cases, we venture to say that, perhaps with the exception of the hand, there is no articular mechanism of the body to which more harm is done by irrational treatment. A glance at the anatomy of the subacromial bursa and its function will make this at once evident. In abduction and elevation of the arm, the tuberosity of the humerus has to glide more or less underneath the acromion, and it is the function of the bursa to make this motion possible. It acts almost like a joint, and may be justly considered a semijoint. As we can see on the opened bursa, the space between the acromion and the humerus shows considerable variation in different positions. With the arm hanging down, and the humerus inwardly rotated, the space is quite large, allowing the finger to pass between the bones. The more the arm is rotated outward, the smaller the space will become; but still a fairly good sized space exists even in full outward rotation.

With elevation of the arm, the mechanical relations of the humerus and acromion change considerably. Here, just on the contrary, the space is relatively greatest with the arm in outward rotation, while with the arm inwardly rotated and elevated the space becomes so narrow that hardly a probe can be passed between the humerus and the acromion. These are the relations under normal conditions. When the walls of the bursa and the adjoining structures are changed in thickness, the space between the bones may change considerably.

When examining a stiff shoulder for the first time, it is, offhand, difficult if not impossible to obtain a clear idea about those relations of the bones, and only by careful observation do the mechanical conditions become distinct. Another point will also be

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evident, namely, that the chances of recovery of the elevation are the better the more free the rotation. Hence the prognosis is generally better when the rotation is not, or not much, restricted than when both elevation and rotation are limited. Cases in which the elevation is free and the rotation greatly restricted are rare. We see them sometimes in the after-care of cases which have been treated for some time with immobilization in full abduction when motion in the frontal or sagittal direction has been restored first.

These anatomic remarks may give a certain idea of the great variability of the subject, and may prove that each case needs individual attention and careful study. Often it is only by prolonged observation that we obtain a certain knowledge of the mechanical conditions. Admitting, therefore, the difficulty of giving routine prescriptions, I shall try to outline the method of treatment as it is carried out in our clinic. In a case in which motion is limited in all directions, the first rule is to find out how much of the restriction is due to muscular contraction, and how much to adhesion or retraction of tissues. Examination of the function of the shoulder at first in the standing and then in the lying position may give a certain idea of the amount of muscle spasm, as in the latter position, by means of more favorable leverage conditions, the deltoid and supraspinatus muscles can work with less strain to the bursa and joint, and this difference will often become more obvious after the pain-lessening application of hot air and massage. We remember patients who, at the first glance, showed a perfectly stiff and rigid shoulder, but gained motion of 40 or 50 degrees during the first treatment. The prognosis in these cases is generally good, but one must take great care to give the treatment a soothing character, and avoid all rough handling. Hot air should be applied for not more than fifteen minutes with a temperature of not more than 180 F.

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The exercise should be done as slow resistive or assistive movements, and at least in the beginning not beyond the range of discomfort, that is, when rotation is 50 degrees free, the resistive exercise should not be done more than 45 degrees. When in such a case the stage of muscular restriction is passed, and that of adhesions or retraction is reached, greater force may be applied, provided lasting pain is avoided.

The treatment then will be carried out in the following way:

The shoulder is baked for fifteen minutes, followed by a gentle rub, massage applied to the muscles of the shoulder and upper arm. Then the patient is placed on a couch or table with a pillow under the head and shoulder, and a smaller pillow under the elbow, thus bringing the humerus in a horizontal position. The operator, standing on the side of the affected shoulder, grasps with one hand the patient's forearm, which is flexed in the elbow, while the other hand steadies the scapula, and at the same time one finger rests on the acromion and another on the tuberosity for an exact control of the motion. Now the operator demonstrates to the patient inward and outward rotation, and makes at first a few light active exercises. Then three or four slow resistive movements are made with complete relaxation of all muscles after each single movement. A few gentle massage manipulations follow, and such are frequently repeated especially with those muscles which show most tendency to spastic contraction. Then, in the same slow manner, abduction, elevation and combined motions are practiced with the fingers, carefully guarding the effect of these exercises on the tuberosity, and its relation to the acromion in every single step.

With progressive improvement, the range of motion and the force applied to the resistances may be increased, and quicker motions, pendulum and other apparatus, cane and pulley exercises, applied as the

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case may require; but we advise against a too early use of such appliances because they are likely to act irritatingly on the bursa, causing pain and muscle spasm and restriction of motion.

These represent the majority of cases of subacute or chronic bursitis, and a certain part of cases of infectious arthritis. In those cases in which adhesions and retraction of tissue are chiefly responsible for the treatment, the prognosis depends, of course, on the actual changes; but even here, by persistent resistive exercise, concentric and eccentric, good function can be restored. The fact that within the last year or two we have not had occasion to use forcible manipulation under an anesthetic may serve as proof that we have been sufficiently satisfied with our conservative method. Two patients who seemed to respond rather slowly had been manipulated in my absence, but were evidently not relieved; on the contrary; the enormous aggravation of the pain and muscular rigidity following the manipulation has furnished us renewed proof of the great superiority of the slower, conservative method which, in most cases, will prove the quickest in the end.

ABSTRACT OF DISCUSSION

Dr. Walter Truslow, Brooklyn: It is rather unfortunate that the reader of the paper could not have had opportunity to develop his full classification. I was interested, however, to note that in the first part the paper failed to give us the etiologic background of some of the conditions dealt with. I want to speak strongly of the use of massage, muscle training and gymnastic work, which Dr. Bucholz so liberally uses. The oculist objects to the indiscriminate sending of patients to the optician, and rightly so; the orthopedic surgeon objects to the ignorant sending of patients to the bracemaker with instructions to make a brace for some part of the body, and rightly so. We all object to the attitude of the osteopath, the chiropractor and others, in claiming everything for gymnastics and passive motions, and rightly so; but do we do our duty in the matter? Do we train ourselves to do this work properly? As muscle training and massage are so valuable for many orthopedic conditions, should we not train ourselves to do them?

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inferences with regard to the presence of this calcareous concretion. We try to use the abduction treatment. Few of the patients are sick enough to stand the restriction of having their arms in the abduction splint.

What has been said with reference to stretching of the joint applies only to the older cases, in which the disease has passed and adhesions alone are causing the disability. I believe that the larger number of shoulder cases are instances of the mild type, and that no positive diagnosis can be made.

Dr. Roland Meisenbach, Buffalo: In considering our shoulder cases, I believe that we should carefully decide whether we are dealing with a real and primary traumatic shoulder, or whether we have an early diseased joint. I have found that the symptoms of an early osteo-arthritis, and also of an early tuberculous shoulder joint, may be the same as those of the traumatic; this is especially true of the traumatic bursitis class.

Dr. C. Hermann Bucholz, Boston: In regard to Dr. Brickner's statement about our inability to recognize any nonadherent type, I would say that I think we can recognize nonadherent bursitis as a clinical type to some extent. I have operated on several patients without limitation of motion, and found adhesions; so I will admit that, from a pathologic point of view, we should not consider this type; but still I agree with Codman that clinical observations justify us in making such a group.

In regard to the time required for the treatment, I admit that I see, in my department, the worst cases. Patients are sent to me from other departments, frequently after not having well responded to quicker methods. The problem is quite large; for example, stiffness resulting from fractures or other injuries of the shoulder cannot, as a rule, be relieved by such quick methods as Jones and others recommend. In these cases we have to do with the actual retraction of the tissues, and these retractions are sometimes very hard.

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ARTHRITIS AND FOREIGN PROTEIN

CHRONIC RHEUMATISM RELIEVED BY INTRAVENOUS INJECTIONS *

HENRY BASCOM THOMAS, M.D.
CHICAGO

Patients with chronic arthritis present a more vital problem in economy to the tax payers of the city and county and to the private hospital than almost any other cases. Their relative number for admission is large, and their stay is usually very long. There were 161 acute and 160 chronic arthritic patients in the County Hospital last year. St. Luke's does not admit chronic cases as a rule, yet many arthritic patients constantly receive careful and prolonged care there. Finally, many of these patients must go to the county or state poorhouses or homes for incurables when they have worn out their welcome in the city institutions.

In the spring of 1916, several patients with chronic arthritis appeared on my service at the County Hospital. They gave a history of treatment by "shots into the vein of something which made them chill and relieved their pain." They proved to be some of the first patients with intravenous injections of typhoid vaccine by Miller and Lusk,[1] whose first article on this new treatment appeared in June, 1916.

Anything which held promise of relief for chronic rheumatism was extremely attractive, and when advocated by experienced men, seemed worthy of an immediate trial.

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* From the Orthopedic Clinics of St. Luke's Hospital and the County Hospital.

1. Miller, J. L., and Lusk, F. B.: The Treatment of Arthritis by the Intravenous Injection of Foreign Protein, The Journal A. M. A., June 3, 1916, p. 1752.

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A government strain of typhoid vaccine made by Dr. Moody at the laboratories of St. Luke's Hospital was used in the cases which form the bases of this report.

It seems to be fairly well established that typhoid vaccine in arthritis does not relieve symptoms by forming antibodies, that it is not a specific therapeutic agent, but that the benefit is derived from the protein carried in the dead bodies of the bacteria which are thought to produce a rise of temperature and hyperleukocytosis, just as other proteins like milk, proteose, horse serum, chicken serum, and sodium nucleinate are thought to do.

In March, 1916, Müller and Weiss,[2] using the vaccine treatment in cases of gonorrheal arthritis, advanced the view that the beneficial effects produced by the vaccine therapy are due to the induced fever, or at least that the fever is a weighty component in these effects, and that the favorable effects are not due, or not mainly due, to the development of specific antibodies. They also state that the therapeutic effects seem to be greater the higher the degree of induced fever, and this is confirmed in my experience. See the case of H. S. below.

Jobling and Petersen,[3] in speaking of the nonspecific factors in the treatment of disease, say:

> It seems probable that the fundamental change on which the majority of [these] biologic reactions are based is one of colloidal dispersion, in that the injections bring about a less dispersed state affecting not only the serum proteins but also the serum lipoids. Such an alteration is sufficient to account for the fluctuations in the ferment-antiferment balance, and in the coagulation mechanism, as well as in the opsonic and complement powers of the serum, although it does not at present explain the increased antibody titer. With this as a basis we can understand that so many and diverse substances can bring about a reaction almost identical clinically and therapeutically. But here, as in so many other biologic problems which have to do with that most complex of tissues, the blood, it seems

2. Müller, R., and Weiss, A.: Fieberbehandlung Gonorrhoischer Komplikationen, Wien. klin. Wchnschr., 1916, 29, 249.

3. Jobling, J. W., and Petersen, William: The Nonspecific Factors in the Treatment of Disease, The Journal A. M. A., June 3, 1916, p. 1753.

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probable that no single factor can be identified as responsible for all the changes which occur, but that a whole train of events is inaugurated when the equilibrium of some of the delicate serum balances is disturbed, all of which tend toward a condition favorable for recovery from infection.

A large percentage of the patients under discussion had subacute and chronic cases, with beginning and advanced joint changes — hard working, ill fed and poorly cared for persons who sought the hospital as a last resort.

Table 1, of twenty cases of the series, gives an idea of the average age, nationality, occupation, civil state and examining-room diagnosis.

Rest in bed and a search for and elimination of the focus of infection is made a prerequisite to the injections in all cases, save in those in which the patients need the immediate relief from suffering which the vaccine gives. These have the treatment at once. If a sufficient interval has elapsed since the last meal, say six or seven hours, the gastro-intestinal reaction is less severe, and the patient less uncomfortable.

In seeking the cause of the arthritis, the following possible sites of infection were kept in mind; tonsils, teeth, gums, sinuses, ears, eyes, urethra, prostate, gall-bladder, heart, gastro-intestinal tract, organs of female pelvis, etc.

In a few of the cases there was no demonstrable focus. In one patient who had a most severe multiple ostearthritis affecting practically all joints, and who killed himself by taking poison, an exceedingly careful postmortem, in which particular attention was given to the urethra and prostate, revealed no cause for the crippling joint condition. Many other cases which I am in the habit of calling clean because the patients present at a glance a favorable hygienic condition — white, clean teeth and pink, hard gums — present no clue which enables us to find a focus of infection. My experience causes me to raise the question whether an obscure infected gland cannot do as much damage as a bad tonsil or an ulcerated tooth.

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TABLE 1.—DATA IN TWENTY CASES

Patient	Age	State	Nationality	Occupation	Examining-Room Diagnosis
M. S.	39	Widow	U. S. A.	Laundress	Arthritis of hip
J. D.	42	Widow	U. S. A.	Nurse	Multiple arthritis
J. S.	54	Widow	Irish	Housework	Hallux valgus and arthritis
L. Z.	56	Married	German	Housework	Arthritis deformans
M. C.	42	Widow	Lithuanian	Janitress	Chronic ostearthritis
E. C.	55	Widow	U. S. A.	Housework	Chronic arthritis
E. S.	28	Single	U. S. A.	Clerk	Multiple arthritis
G. E.	22	Single	U. S. A.	College	Multiple arthritis
M. C.	29	Married	German	Clerk	Multiple arthritis
A. P.	44	Married	Hungarian	Laborer	Chronic arthritis
F. S.	53	Married	German	Laborer	Ostearthritis
A. R.	36	Single	Russian	Laborer	Pes planus; chronic arthritis
C. H.	54	Married	Swedish	Laborer	Hallux valgus; arthritis
H. G.	32	Married	German	Laborer	Ostearthritis
J. O.	42	Married	Austrian	.....	Arthritis deformans
H. W. (colored).	32	Married	U. S. A.	Laborer	Gonorrheal spurs; flat foot
R. T. (colored).	18	Single	U. S. A.	Domestic	Arthritis
H. R.	23	Married	Russian	Factory	Arthritis
A. A.	54	Married	Italian	Laborer	Gonorrheal arthritis
G. L.	49	Single	Norwegian	Iron-Molder	Flat feet; arthritis

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In subacute and chronic cases of ostearthritis one will make no mistake if he prescribes 50 million typhoid vaccine intravenously, and in those cases which react only moderately cautiously raises the amount at intervals of two or three days to 75 million bacteria at an injection.

In eighty-six subacute and chronic cases treated, I have not yet seen harm done or alarming symptoms result from this treatment. Indirectly, several fatal cases have come to my attention, but they were, in my opinion, acute cases with alarming coexisting illness, and therefore should not be used as arguments against the free use of the vaccine in the general run of subacute and chronic cases coming to the attention of the orthopedist. Moderately advanced heart and kidney disease and tuberculosis of the lungs have not been considered sufficient reason for withholding the protein, but these diseases have been looked on as demanding carefulness in (*a*) the preparation of the patient, particular care being taken that the stomach is empty for several hours before the injection; and (*b*) the administration of a small initial dose, this to be increased gradually, but only after all the disagreeable symptoms of the former injection have disappeared and the appetite has returned.

RESULTS OF THE VACCINE

These may best be described under three heads: (1) the immediate effect; (2) the early relief from pain, and (3) the end-results of the treatment.

1. *Immediate Effect.*—This is an uncomfortable feeling which ranges from slight to very severe, accompanied by a chill, rise of temperature and emesis. The marked reaction is usually not so evident in the chronic as in the acute cases. The gastro-intestinal symptoms are less marked in cases of equal chronicity in which food has been withheld for four or six hours before the injection. The temperature charts in old cases frequently show a higher fever following the second and third injection.

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CASE 1.—H. R., who showed no reaction to first injection, reacted to second with temperature of 101.2 and leukocytes 20,000. Dates of injections, leukocytes, temperature, pulse and respiration are shown in Table 2.

TABLE 2.—PROTOCOL OF CASE 1

6-29-16, 7:30, 75 million

Leukocyte Count	Temperature	Pulse	Respiration
Before injection, 13,600	98	76	20
Four hours later, 13,950	97.2	64	20
Twenty-four hours later, 13,800	97.4	60	20

No reaction to injection.

7-6-16, 4:30, 75 million

Leukocyte count:	Temperature	Pulse	Respiration
Before injection, 14,200	98.8	76	20
Three hours later, 12,000	101.2	112	22
Sixteen hours later, 20,000	99	80	20
Eighteen hours later, 12,200	98	76	18

There was headache and nausea in two hours. Emesis in two hours, forty minutes. Severe headache in twenty-eight hours.

CASE 2.—H. S. was injected for the first time July 25, 1916, at noon. The temperature rose to 104.4 F.; at the second injection it reached 106 F. Cyanosis developed. This represents the most severe reaction among my patients. Unfortunately the blood counts were not taken. Part of the record is given in Table 3.

TABLE 3.—PROTOCOL OF CASE 2

	Temperature	Pulse	Respiration
75 million at noon	99	92	18
Pain in feet and head 11:03	.2	120	24
Pain in feet and head 2 p. m.	104	120	24
Severe headache at 3 p. m.	104.4	124	22
Feels better at 6 p. m.	103	120	22
Head and feet pain at 8 p. m.	104.4	120	28
Injection 7-27-16: 1 p. m.; 75 million	99.4	100	26
Chill, cyanosis, nausea, emesis at 2 p.m.	105	100	26
Headache 3:30 p. m.	106	140	28

Discharged 8-30-16. Recovery.

2. *Early Relief from Pain.*—The practically complete relief from all joint pains and the optimism of the patient a few hours after the vaccine are most striking and pleasing factors in virtually all these cases. The patients feel cured. They are encouraged and hopeful. Following an interval of two days the pain usually reappears, but this interval decreases with the number of injections. After from twelve to twenty-four treatments over a period of from one to two

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months, these patients are in most cases able to leave the hospital as cured. Attention is, of course, given to any operative need the case may present, such as heel-spurs, and to proper balance.

3. *End-Results of the Treatment.*—These are not as satisfactory in my cases as Miller and Lusk report in their papers. The relief of pain has not been permanent in more than 30 per cent. of the patients treated. The remaining cases, however, have done much better than previously treated cases, and I consider this method superior to others I have used. The marked alleviation of symptoms and small percentage of dangerous results must eventually force it into more general use.

30 North Michigan Avenue.

ABSTRACT OF DISCUSSION

Dr. Walter G. Stern, Cleveland: The injection of a large amount of foreign protein into the blood stream is, of course, not without danger; but anything that promises relief in this (always intractable) class of cases is worthy of discussion. I have had no experience in the treatment of gonorrheal arthritis with typhoid vaccines, yet I cannot conceive how the typhoid vaccine protein would be superior to the gonorrheal vaccine protein, especially that of the strain used for the complement fixation test. Gonorrheal vaccine used subcutaneously never succeeded in curing acute gonorrheal arthritis, but it may be that the intravenous exhibition would be more efficacious. The clinical results from the use of foreign protein in chronic hypertrophic arthritis may be divided into three distinct stages: (1) the stage of damage from the injection of foreign protein, as shown by increased rigors, nausea, rise of temperature, and a higher leukocyte count; (2) the stage of improvement in symptoms, familiar to all of us who have tried to treat arthritis by any means; we have all in the past used injections of the thymus and other glands of internal secretion, and in almost all instances the patients say that they are better, and they are better for the time being; (3) but then comes the sad third stage of relapse, and in my experience in the use of typhoid vaccines the third stage here is the same as in the use of injections of the organs of internal secretion. Some patients do well with injections of thymus, and then relapse, and it is the same with injections of pituitary gland. I am sorry to have to confess that in all my cases but one, the third stage after the typhoid vaccine injections was the same as the third

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stage after injections of any of the organs of internal secretion. The successes of Drs. Thomas and Miller with the typhoid protein are, however, so striking that I feel the proposed treatment is worthy of an extended trial.

Dr. R. O. Meisenbach, Buffalo: I should like to ask Dr. Thomas whether the patients that he has been treating had been having an elevation of temperature over a long period —say two months.

Dr. Henry B. Thomas, Chicago: It is not a question of the kind of vaccine; dead bodies of bacilli, some kind of foreign protein, put into the circulatory system will cause the reaction. There is no advantage claimed for the typhoid vaccine over the gonorrheal or other vaccines containing foreign protein. With regard to the temperature, some of the subacute cases ran a moderate temperature, but most of them did not show as much temperature as the acute cases.

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FRACTURES

H. R. ALLEN, M.D.
INDIANAPOLIS

In presenting this paper I cannot include all fractures, nor all of the details of any one fracture. I have selected certain conventional methods usually employed in every day practice, and I shall attempt to show that those methods are defective, and with each defect I shall submit my reasons for calling them defective, in each incident supplying what I consider a correction of the defective method. In other words, I believe there are sound logical reasons that explain bad results in treating fractures, and I also believe that better and more consistent results will follow better methods. The better methods, at least, are logical, they are consistent with the unalterable laws of nature, and they are approved by physicists and mechanical engineers.

By directing my first attack on the popular use of the weight and pulley in treating broken femurs, I shall bring to light the absurdity involved in at least one conventional method. However, if any one can defend this traditional usage, we shall all be glad to hear from him.

Back in the dark ages and probably before that time, and at the present time, bone setters searched for a consistent force to hold broken bones in a constant normal position. Hence they selected the constant force of gravity, knowing that bones would unite in the position in which they were held. They did not stop to consider that they were using the force of gravity, first, on the patient's body, where it acted as a fixation force, and secondly, on his leg, where it

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acted as an active kinetic force to oppose the most varied of all opposing influences which are to be found in the varied and irregular contractions of muscle tissue. Muscle tissue, if prodded with a sharp piece of bone, may exhibit spastic contractions, a tremor, relaxation or irregular contractions, all of which are to be opposed and balanced between the active force of gravity applied through the weight and pulley, and the fixation force of gravity applied to the body of the patient as it holds him down on his bed.

It is a difficult matter to convince any physicist that there is any balance or constancy in a formula that uses gravity as a fixation force on one end, and the active and acting force of gravity on the other end, while between the two there is present the unconstant and varying opposition of muscle contractures. Hence, in defending the use of the weight and pulley, I propose not to drift into a dissertation on the wonderful results following its employment, but rather to adhere to the fixed basic mechanical principle involved. Those wonderful results obtained can be logically explained and obtained without the weight and pulley. What we are really striving for is the hope of putting our specialty on an unassailable basis, at least from a mechanical point of view, and I desire to see eliminated all possible guesswork and bunglesome misuse of mechanical principles in this age of sound mechanics. If I am wrong in the hope or in my mechanical claims, we should all know it.

Believing that there is no constancy, balance or logic in the principle of the weight and pulley, I will, before suggesting some substitute, take up one more absurd item in regard to the amount of the weight used with the pulley.

Figure 1 *A* represents a young man with his leg fastened securely to an iron frame. Without unusual effort he lifts the entire weight of his body directly from the floor. Suppose he weighs 225 or 250 pounds; then, while lifted clear of the floor, the only

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part of his body not lifted by the extensor muscle would be his leg and foot which rest on the steel frames. In other words, the rectus muscle through the agency of the femur as a lever is lifting a total of 200 pounds.

Figure 1 *D* represents the femur laid off as a scale beam; — 1 represents the length beyond the fulcrum *O*, while more than 10 units extend back to the long arm of the lever. Thus when he lifts his body, 10×200 pounds represents the strain or traction of the rectus muscle. I believe no one could tolerate the traction of 1 ton during the time of bone union.

In Figure 1 *C* it will be noted that the cross-section of the thigh at point *B* represents the total amount of the thigh muscles capable of making direct traction. The total traction released for activity in the event of a fractured femur would amount to several tons. It will be observed that the segment in the cross-section indicated by vertical lines represents the rectus. The lateral unstriated segments plus the lower, laterally striated segments exceed the rectus by five or six to one. This being the case, what special or particular function would a 10, or 50, or 100 pound weight perform in the event that the patient sneezed or contracted his thigh muscles, or during a spasmodic contraction while sleeping or dreaming? We all know that some muscles tire out and others never seem to offer much resistance. We also know the spastic type of muscles that resist, such as a finger in writers' cramp.

If the formula or principle of the weight and pulley is wrong, and if the weight is insignificant, then it behooves us to employ correct mechanical principles. The idea is constant normal position. We must use fixation energy for fixation purposes.

The force of gravity holds the mountain (Fig. 2) in a fixed position. Hence this use of gravity is a fixation force. But the air, the sea, the ship and the locomotive are also acted on constantly by gravity,

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but their location is not fixed. The locomotive can be fixed on a steep grade through the fixation energy of its brakes, and the ship can be fixed by the fixation energy of anchor chains over its bow and stern. An appropriate way to apply fixation energy to a broken femur is through strips of adhesive plaster applied to the leg extending above the knee, regarded as the lower fixation area, while the upper fixation areas might be the tuberosity of the ischium, or the patient could lie down on adhesive plaster that will stick to the side of his back corresponding to the side of the broken femur. Having two fixation areas, it is possible to apply fixation energy, and I would recommend a traction screw for the top adhesive strip and for the lower. When these two screws have drawn the thigh to its proper length, they will exert no further activity, but will assume the duty of fixation energy. If the adhesive plaster creeps or slips, additional turns of the traction screw will guarantee fixation energy at constant normal distance. The pulley and weight do not represent fixation, but there is a permanency guaranteed by traction screws.

Figure 3 represents the mechanical difference between fixation energy and the weight and pulley. The weight and pulley would allow the body of the patient to sag. The same is true if the traction screws were employed, provided the two tables were mounted on rollers. But, if fixation energy should be applied (by first nailing the tables in place on the floor), then the traction screws would drag the patient's body to a straight horizontal line like a tight rope, if such unpardonable traction were used. By placing the patient in bed the traction screws merely guarantee a fixed distance between themselves, any part of which fixed distance may be occupied by the patient. If steel pins above and below the fracture are held at a fixed distance apart, they serve as fixation energy. A Lane plate serves as fixation energy. If the square ends of bone rest against each other, or if the bony spicules

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and their retaining notches rest against each other, there is fixation energy. But, if the patient disturbs such contact by using the bed pan, or by coughing or other commotion, then the bones are apt to be displaced and must be reduced to opposing position again. It is easy to understand how a good result might be obtained with the projecting spicules and notches of bone, even if a trifling weight was or was not employed. If the projecting spicules of bones caught and hung in muscle tissue, a fair result might occur in spite of a trifling weight and pulley.

In regard to the reduction of the shaft of the femur, there are cases in which screw traction will draw the fragments down past each other and permit the ragged ends of bone to come into their proper places. There are other cases, and plenty of them, in which the hamstrings and gastrocnemius and soleus muscles prevent reduction, provided the knee joint is extended.

Figure 4 *A* represents the knee flexed and relaxed, while *B* represents the knee extended with the posterior muscles tense. Any one who will extend the knee joint will find the hamstrings tight. They will surely be loose if the knee joint is flexed. Now the so-called transverse fractures are not like the sawed edges of a bone. If they were, the bones would go into place with the knee extended. But the transverse fracture is transverse roughly with bony spicules and notches left. Hence, in order to get the bones in line, the muscles must provide the requisite length for the rough areas to pass each other. But if the muscles are tight, when the knee is extended, they will not stretch enough to permit the rough ends to pass each other; consequently, the thigh must be muscularly unlocked by flexing the knee. Under knee flexion the bones easily go into place and, in these cases, will lock in place if the knee joint is again extended. This matter of unlocking the thigh is so helpful that it is strange it could have escaped mention in our textbooks.

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There is another item involving the use or misuse of good mechanics that should be mentioned. In the treatment of hip joint disease and in manipulation of certain fractures and dislocations, a line of traction parallel with the neck of the femur is sought. It is regularly attempted, as shown in Figure 5 *E*. Adhesive plasters, *B B*, on the leg have traction applied to them, while a band, *A*, is passed around the thigh and is pulled laterally. The composite result of the traction on *A* and *B* is supposed to result in a downward and outward traction in line with or parallel to the neck of the femur pointing from the acetabulum to *C*. The actual result, however, is almost directly at right angles, as indicated by the arrow pointing toward *D*.

The desired traction can be accomplished by following the unusual suggestion indicated in Figure 5 *F*, or to a limited degree by following the lines of pressure indicated by the arrows in *G*.

Figure 6 indicates one of the important triangles of the thigh in regard to which I wrote quite extensively twenty years ago. Two sides of the triangle are bone, while the third is muscle. If one side or one angle of a triangle is changed, the entire triangle is altered. Thus, if the side *A–C* is bent inward, the rest of the triangle must change. It does change, and as the femur is dislocated or fractured and free to move and the rest of the triangle is intact, the shaft or line *C–B* will travel upward or outward or in the two directions simultaneously.

Figure 7 is interesting in showing how a little pressure on the gracilis and adductors will become a tremendous upward pressure. If in *B* there is a 1,000 pound weight suspended by a rope, a very slight pressure at the middle of the rope will bend it, and if bent at all the weight has been lifted, although it may have been lifted only a fraction of an inch; yet it is true that 1,000 pounds has been lifted.

C represents the same state of affairs, except that the 1,000 pounds are secured to the top of a rod, while

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the rope is secured to the bottom of the rod. A pressure of a few pounds, or even a few ounces, against the middle of the rope will produce a pressure of a thousand pounds upward. This illustrates how we may create tremendous destructive pressure in the head of the femur and acetabulum by applying lateral pressure or traction to the gracilis or adductor muscles.

D represents, in all fairness, the increased pressure required to lift the same weight by applying more pressure or traction when the rope makes an angle of about 90 degrees. But the gracilis and the adductors make no such angle.

Figure 8 represents various positions employed in using the weight and pulley method.

In considering the basic mechanical principles appropriate to the treatment of fractured femurs, the ingenuity of the physician will be greatly improved if he does not consider this or that transverse or spiral or compound complicated fracture, but pictures constantly in his mind how he would treat a patient who had the middle third of the shaft entirely shattered and disconnected. By keeping this picture in mind, the physician will be stimulated to consider basic principles. If they are appropriate to a shattered femur they might be appropriate to a more simple form of fracture, since after all the thigh is merely an eccentric muscle tube with a bone filling its lumen. Of course a shattered or simple fracture of the neck of the femur are treated alike, as fractures of the neck of the femur are the easiest of all fractures to treat without deformity or shortness. The rules of fixation energy for fixation purposes are borne out here as elsewhere, and I know of no case of nonunion or "ligamentous union" which is genuinely nonunion to have resulted from this method of treatment at any age. In very old people of 80 or 90 years the bones unite. These patients may die with or without any treatment, but I believe their chances are better if no

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analgesic or any anesthetic is used at any time during the period between accident and recovery, and there is no occasion for using anesthesia or analgesics, as the treatment is not painful nor pain-inflicting, but is absolutely comforting from the moment it is begun. This, of course, is a statement to be substantiated by the physician's own patients when this method is adopted. The simplicity of the method is the feature most difficult of comprehension to the average practitioner who employs it. An ordinary army stretcher with a traction screw or strap at each end and a hole in the canvas for the bed pan service is a simple, direct and efficient fracture splint. But the details are trivial; the essential features are the selection of appropriate mechanical principles.

Allied to fractures of the femur are fractures of the humerus. Here the principle of fixation energy for fixation purposes is equally essential. Instead of using the tuberosity of the ischium as a superior fixation point, we use the muscles in front and behind the axillary space protecting the blood vessels and nerves from pressure. The inferior fixation area is the angle pad anterior to the elbow resting down on the forearm and back against the arm.

In Figure 9 a band under the wrist serves to hold the elbow in right angle position, affording a base for the angle pad. This type of splint is not new and untried, but has been in use by me for twenty-five years. The wire and adhesive plaster brace, as will be noted at *C*, is light, rigid and clean, permits free inspection at all times and is easily adjusted, is neither expensive nor difficult to construct, and is efficient in affording constant diastasis and maintaining constant normal length of humerus. The fixation area is supplied by the superior axillary base and the lower base on the forearm close to the arm as shown in Figure 9 *C*. Likewise, *B* represents the axillary sling, crutch or bandage showing the pectoralis muscles in front and the latissimus dorsi behind,

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against which the padded sling rests protecting the axillary blood vessels and nerves. *A* is a transverse section through the arm and chest showing that the padded axillary sling should not compress the blood vessels or nerves of the arm.

Figure 10 shows in series the construction of the angle or elbow pad. I have frequently made them out of empty ether cans. Have the nurse hold the can over a gas flame until the solder melts, quickly throw the can on the tile floor to prevent its resoldering itself, then cut and bend it, stick it together with adhesive plaster and pad it, and apply it with bandages that do not encompass the arm or forearm, but attach to the brace as shown in the drawing.

Fractures of both bones of the forearm seem to give considerable trouble for a variety of reasons. These bones are provided not only with muscles paralleling them capable of long axis compression, but also diagonal pronators and supinators, and one other not to be forgotten is the rotator. The last and universally overlooked condition is the fascia. The fascia is inelastic, built to fit over a forearm containing only two bones. If the bones are broken obliquely and override each other, the inelastic fascia is called on to provide space for three or four bones instead of two.

Figure 11 *A* represents normal cross-section of the forearm, showing the interosseus membrane in a straight line. *B* represents fractured bones overriding and taxing the inelastic fascia to its full capacity. The interosseus membrane no longer occupies a straight line position.

A frequently used method of treatment consists, first, of traction, and, second, the application of a padded separator to be crowded down between the bones, as shown at *F*. If the fascia is loose and flabby, this scheme might be feasible; but after fracture there is usually sufficient swelling to fill the fascia to its capacity. If already tense, then any pressure will draw the bones closer together instead of separating

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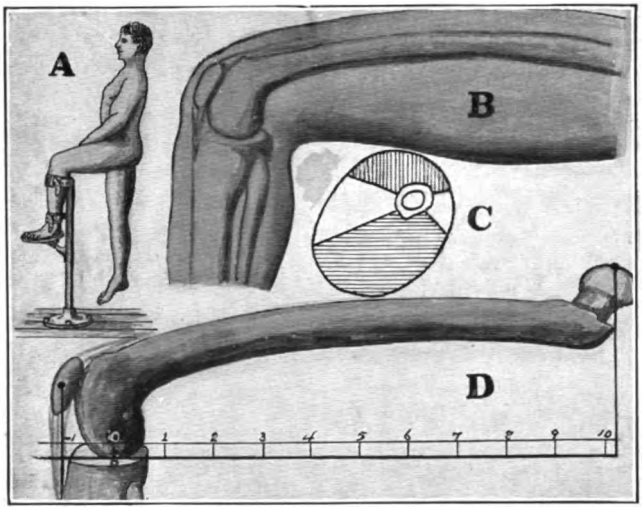

Fig. 1.—Mechanical principles involved in correcting a fracture of the femur: *A*, the powerful leverage of the femur in lifting the body; *B*, thigh muscles which cause direct traction; *C*, cross-section of the thigh illustrating groups of muscles concerned in reducing fracture of femur; *D*, the femur pictured as a scale beam.

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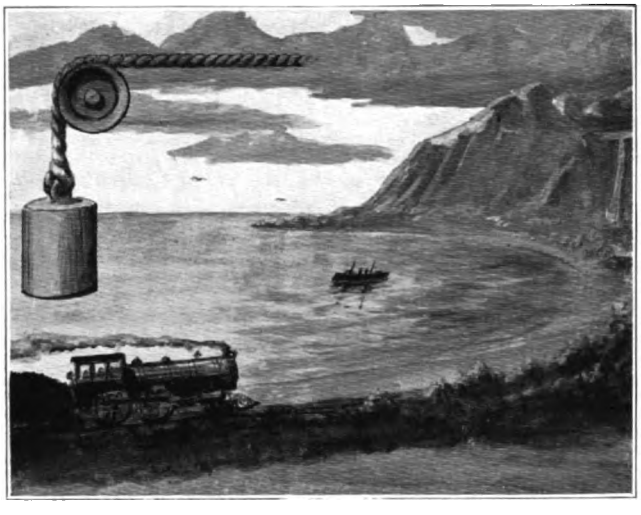

Fig. 2.—Several uses of the force of gravity. In the first place the air is held on the surface and in the crevices of the earth just as the sea is held. Both air and sea are mobile masses. The locomotive and the ship also are mobile masses. One may be locked in place by brakes and the other by anchors. The mountain is permanently locked in its place by gravity. Gravity constantly acts on the locomotive and the ship, but does not restrict them to fixed localities. The mountain lake (upper right hand corner) and its waterfall represent two forms of energy. The lake represents potential energy, while the waterfall represents kinetic energy. The active force of gravity is pulling the water out of the lake to the level surface of the earth, just as the weight and the rope and the pulley in the upper left hand corner represent the mobile active force of gravity. The pulley is held in place by any appropriate fixation energy, but the force of gravity, which is constant and unalterable exerts its downward efforts on the weight. These childish primer differentiations of the force of gravity are abused too frequently and sometimes contradicted in our books and teaching and our thinking.

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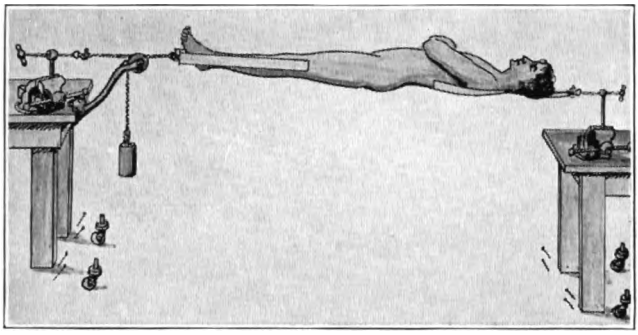

Fig. 3.—The mechanical difference between fixation energy and the weight and pulley. Fixation of support is secured by nailing the two tables to the floor instead of having them mobile on the casters, and thus the patient's body may be fixed as desired.

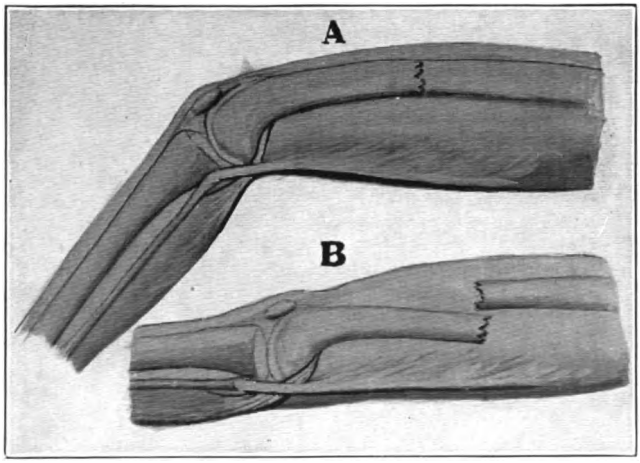

Fig. 4.—Unlocking the thigh so as to approximate the fractured ends: *A*, the knee joint flexed and muscles relaxed with bone fragments in perfect apposition; *B*, the leg extended and the fragments displaced.

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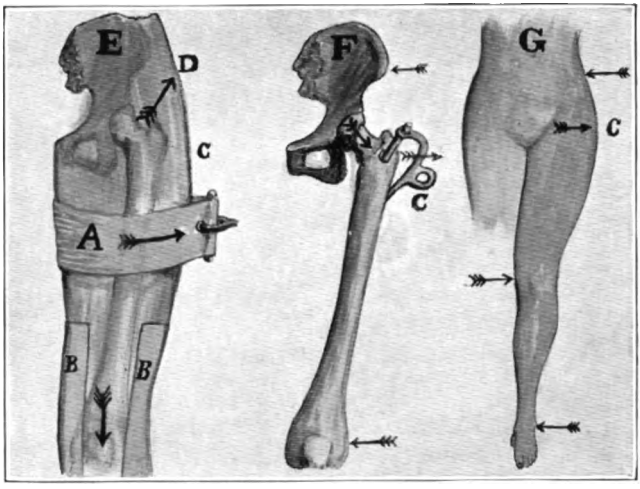

Fig. 5.—Traction to be applied in a line parallel with the neck of the femur: *A*, band applying lateral traction; *B*, adhesive strips making downward and outward traction in line with the neck of the femur pointing from the acetabulum to *C*; arrow pointing to *D*, actual result of such traction; *F*, proper position maintained by downward and lateral traction as indicated by arrows; *G*, points of pressure at which desired traction is secured.

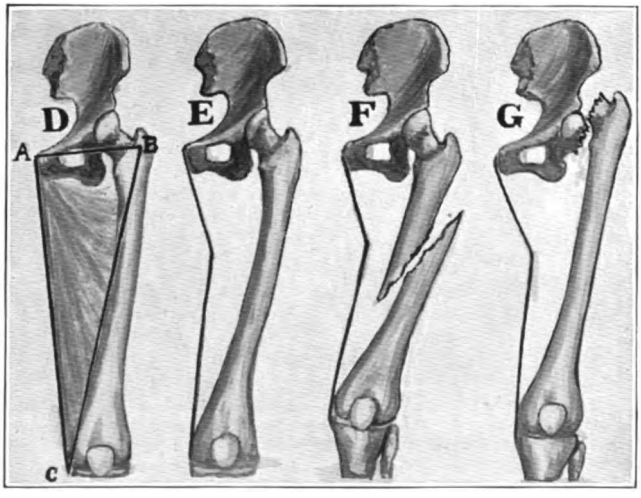

Fig. 6.—Triangles, two sides bone and one side muscle; if line *A-C* (muscle side) is altered, bone shaft *C-B* will travel upward or outward, as shown in *E*, *F* and *G*.

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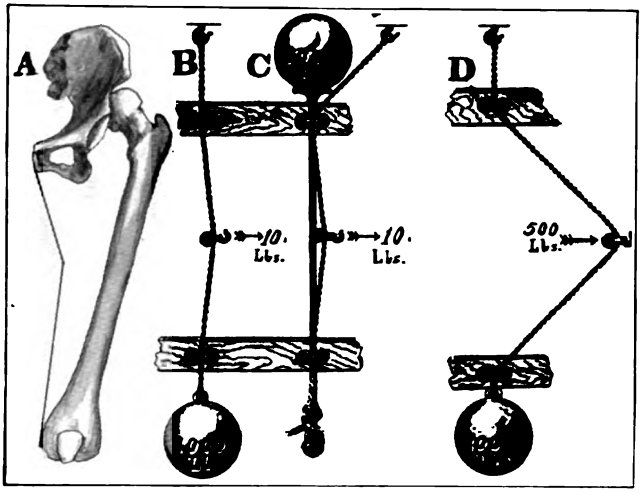

Fig. 7.—Illustrations of possible destructive pressure on the head of the femur and acetabulum by applying lateral pressure or traction to the gracilis or adductor muscles: *A*, displacement of the femoral head through improper traction or pressure; *B*, slight lateral traction in the center causing weight to rise; *C*, weight on top of rod raised by lateral traction; *D*, extreme traction required to lift the same weight to an angle of 90 degrees.

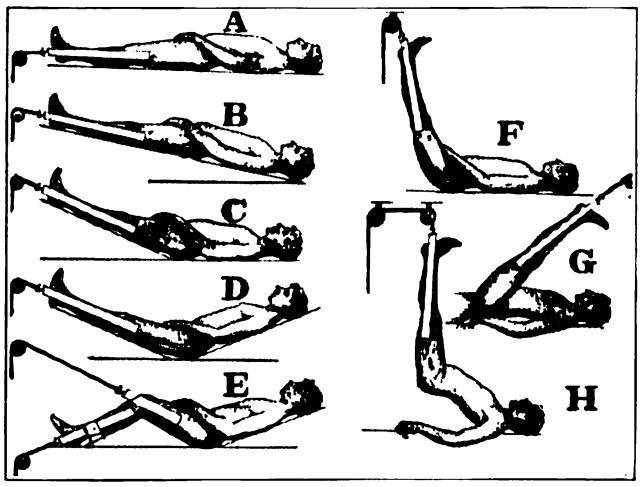

Fig. 8.—Various positions in which the patient may be placed when traction is made with weight and pulley.

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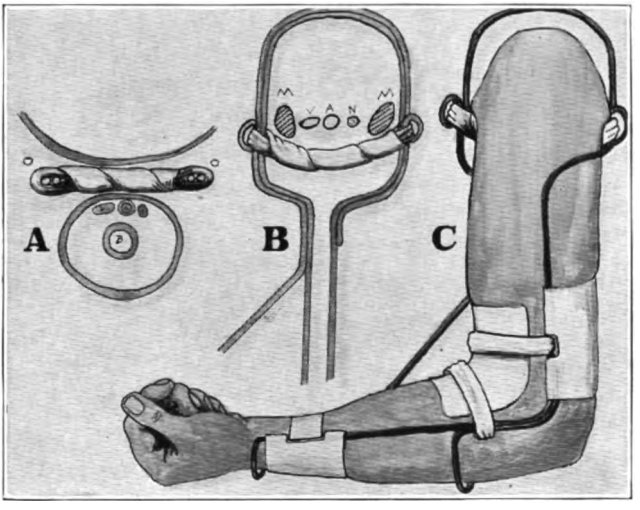

Fig. 9.—The principle of fixation energy as applied to fractures of the humerus: *A*, cross section of the arm illustrating the relationship of vessels and nerves to the humerus and showing the correct position of the axillary sling to prevent compression of the blood vessels, and nerves; *B*, relation of important structures to the padded axillary sling; *C*, axillary sling and wire brace applied so as to hold the humerus in the correct position.

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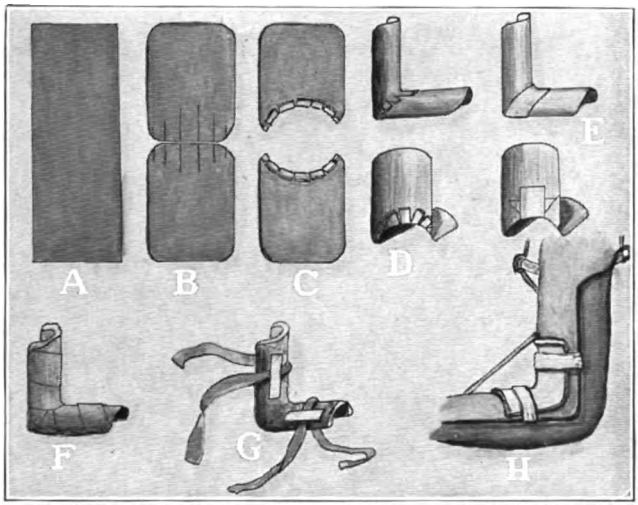

Fig. 10.—Method of construction of the angle or elbow pad from an ether can: *A*, ether can flattened out; *B*, ends cut ready for bending; *C*, ends curved; *D*, ends approximated to form an angle; *E*, adhesive strips fasten ends together; *F*, the can padded; *G*, arm straps placed in position; *H*, the elbow support applied.

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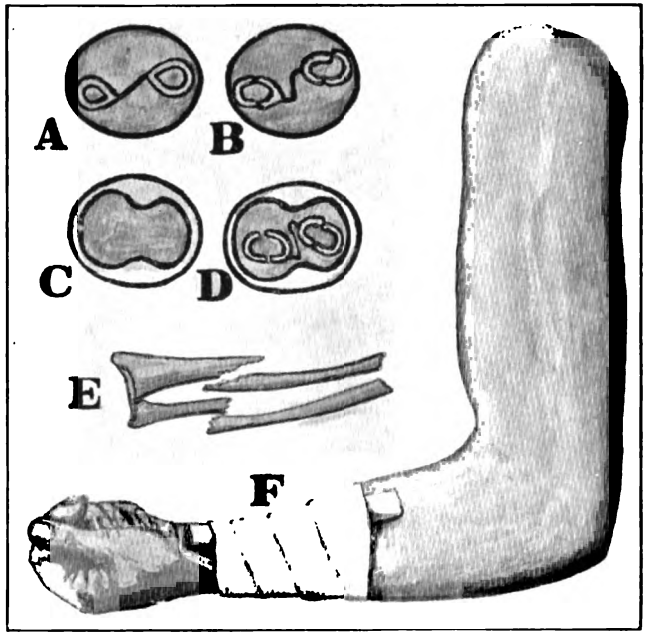

Fig. 11.—Importance of the interosseus membrane in the correct treatment of a fracture: *A*, normal straight position of the interosseus membrane; *B*, curving of the membrane due to overriding of fractured bones; *C* and *D*, external pressure causing faulty position of fracture, since it will tend to force the bones together; *E*, overriding in fractures of the forearm; *F*, commonly used padded separator, which should not be employed, as it applies undesirable compression.

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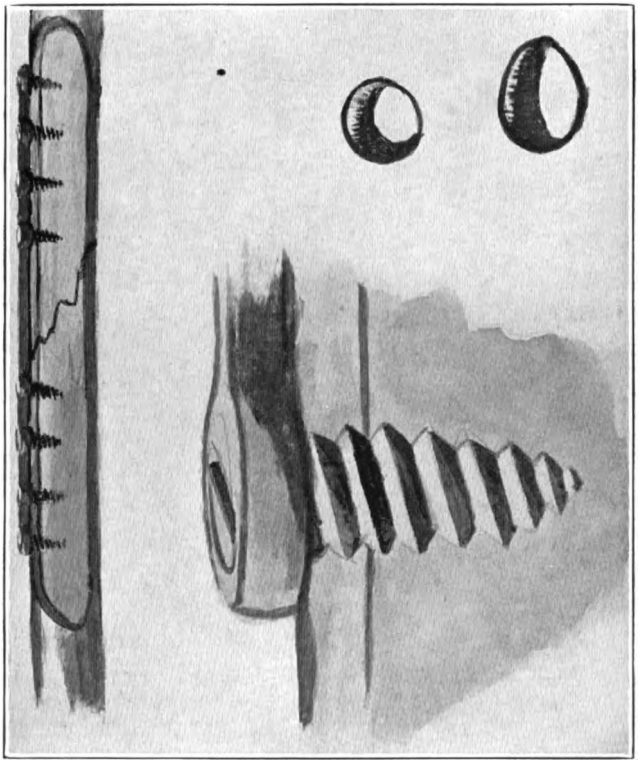

Fig. 12.—Lane plate applied so as to unite a fracture. Note that only about two turns of the thread of the screw are in the hard substance of the bone; the remaining threads are within the lumen of the bone.

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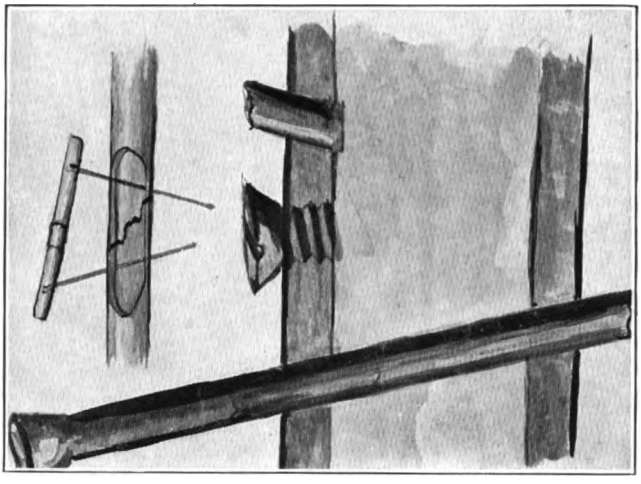

Fig. 13.—Bone gimlet in position: Advantages in the use of pins which transfix the entire forearm.

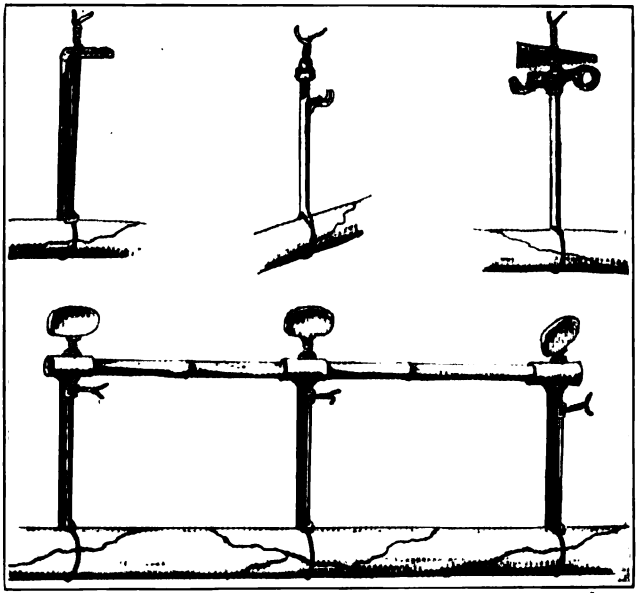

Fig. 14.—Different types of wire stabilizers which are indispensable for use in badly shattered bones.

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them. This is shown at *C* and *D*. It is a well known and established fact that a circle surrounds the greatest area of any geometric figure for a given fixed length of peripheral line. Consequently, if the circle is compressed at any point, the compression is equal for all parts and the compression is extended to the contents of the circle. Therefore the intervening separation pad becomes an interosseus approximator, and obviously should not be used.

The question of using fixation energy in this case becomes complicated. Some experienced operators use Lane plates, although Lane informs us that they are not as good for arms and forearms as they are for legs and thighs. I dare say many physicians have had good and bad results with them.

Figure 12 shows a Lane plate installed. It will be noted that only one or two turns of thread are confined to the durable, hard shaft of the bone, while six or seven turns of the thread extend into the open space of the canal of the bone. Of course, no efficiency accompanies this unengaged portion of the screw. Furthermore, the round hole that fits so snugly the newly installed screw becomes oval or egg-shaped in a week or two, and then even the upper thread or two become as useless as those sticking down into the marrow or open canal.

Figure 13 represents the bone gimlet with its low melting alloy handle compared with the screw. It will be noted that the screw at best has only one-eighth to three-sixteenths inch bearing, while the pin goes clear through the bone, engaging both sides. Now the little round holes for the pins become just as oval as they do for the screws. The difference is that the pins transfix the entire forearm, and at all times provide external control over internal conditions. If the pins become loose, the slack can be taken up outside. It cannot be taken up with a Lane plate, but the plate can slough out while the pins remain in position. In the event that the Lane plates succeed in staying in,

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they remain in forever; but the pins are removed after bone union, and the forearm is not half human and half hardware. Another advantage of the pin is the long leverage obtained from passing from one side of the bone to the other. The strain is divided and the holes remain round longer. The details concerning lack of infection and freedom from pain have been covered in previous papers, although they are open for discussion at any time.

The last fixation device that I shall take up is the wire stabilizer shown in Figure 14. In this diagram there are presented four or five technically different types of wire stabilizers attached internally to the broken bone and externally to the straight edge, which straight edge is usually made of the low melting alloy. In badly shattered bones these stabilizers and external straight edges are indispensable. I prefer the plain flat metal to the tube instruments. Sterilization is more certain and easier to accomplish. This device forms the simplest type of stabilizer.

In passing out models in previous years I have always found some enthusiast who could not resist tightening up the wire snare around the bones in the model. He usually broke the wire under screw traction and spoiled the model for the next man who desired to look at it.

CONCLUSIONS

I trust that I have been both fair and successful in presenting just a few of the many defects in treating fractures, and also successful in presenting efficient and unquestionably sound remedies for the methods I have referred to as inappropriate or deficient.

In the department of mechanical surgery, the surgeon's methods will be judged to some extent by their mechanical soundness. Consequently, fractures and dislocations and other cases involving mechanical problems will be referred to that department which is the most efficient and most capable of treating them.

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If it can be shown that we can best treat these patients, they will not be classed as general surgical cases.

1899 North Illinois Street.

ABSTRACT OF DISCUSSION

Dr. Jefferson D. Griffith, Kansas City, Mo.: Fractures of the long bones, especially the fractures of both bones of the forearm, are difficult to treat and get a perfect result. One may get a functional result with the bones overlapping, and a useful arm, but the thing is, How can we get a perfect result? We can all use this apparatus of Dr. Allen's. I think very well of it. The claim made of reducing and having an aseptic condition is all right.

Some years ago Dr. Parkhill of Denver employed the same principle, with screws and clamps which he connected afterward. They could be put on without any trouble at all with the patient under an anesthetic. I have used his device, and I could succeed in maintaining reduction very well with it after I got it on. But it required the use of his complete outfit, which you must have on hand before you commence reducing the fracture. After you have the pins through, by Dr. Allen's method, you have to use the fusion clamp to maintain the malleable metals in position. If this can be done easily, I like it. The Parkhill method was the same as that of Dr. Allen, except that it had the screws with it, with movable plates on both sides. I have his apparatus at home now and have used it in fractured femurs and forearms. I like Dr. Allen's method much better, I think, if I can find a way to get at it and do it easily.

Dr. Edwin W. Ryerson, Chicago: I should like to ask whether Dr. Allen has any difficulty with paralysis from the crutch under the arm in fractures of the humerus treated by his ingenious apparatus.

Dr. Joseph E. Root, Hartford, Conn.: I wish to emphasize the value of a constant fixation, instead of the old method of using a weight and pulley, which are inconstant. We have in Connecticut a celebrated family of Swedes who are natural bonesetters. The best representative of this family once made this remark, which has always stuck with me, and has been my guide in my entire work with bone: "Doctor, if you put on a variable extension,"—he referred to the ordinary weight and pulley—"you will have trouble. As long as you fight the muscles, they will fight you, and you will gain nothing but constant misery to the patient and a bad result." I have always worked on that principle. If you employ such an extension, you have a see-saw all the time. The pulley never lets up, and sets up a source of irritation to the muscles which cannot be overcome.

I do not think it is just to criticize means to an end. Every man gets results by methods of his own; but so long as his

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results are good, he should stand by his own methods. The method of Dr. Allen is unique, and I can see some difficulties in its ordinary application.

Dr. John Ridlon, Chicago: It is true that the general surgeon and the general practitioner still use weight and pulley traction in the treatment of fractures, but I did not know that any orthopedic surgeon used weight and pulley traction now in any line of work. I have not used any variable traction for more than twenty years, and I hope that no orthopedic man is any longer doing it. The main point is not whether we shall use pins in this way or in Parkhill's way, or splints with fixed traction, or plaster-of-Paris. The meat is to put the fragments in place—in common parlance, to set the fracture; and I do not know any way by which one man can tell another that he knows that he has set any individual fracture. That is a personal question; and he either thinks he has set it or is in doubt whether he has set it or not. If we really set a fracture, we can hold it set by almost any fixation apparatus. I do not think that Dr. Allen has shown us how we can know with certainty that we have set any fracture.

Dr. Albert H. Freiberg, Cincinnati: I looked forward to hearing the paper with some anticipation, and after hearing it felt keen disappointment, because I have heard substantially the same principles enunciated and the same apparatus shown by Dr. Allen for the last three successive years. I had felt that this time I was going to come and hear, not simply that a broken bone was to be treated like a broken table leg and by the same mechanical principles, but that I should hear Dr. Allen tell what he has done and see him show it, which, after all, is the "milk in the coconut." I am still unaware, moreover, what this fusible metal consists of. Dr. Allen's method is ingenious, but whether it works out in practice is another matter; and I think that he owes it to us to show us that it does work out in practice by exhibiting tangible results.

Dr. Henry Keller, New York: I should like to ask Dr. Allen whether he is confining himself to the treatment of cases not amenable to simple methods of treatment in performing this operation, or whether he uses this method in every case. There is a social question involved in that. A good many patients, as soon as you tell them that there is to be an operation, will get frightened. In using this method, asepsis being of great importance, you have to take the patients to a hospital, whether you are dealing with fractures of the humerus or fractures of any other part. The general practitioner has something to say about this. When he calls in a consultant he does so because he wants the cooperation and advice of an expert. If you are going to advocate that every patient is to be treated with pins and

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must be taken to a hospital, that will simply keep the general practitioner from calling in a consultant and lead him to do the work himself, for fear that the patient will be taken away from him. A great deal of work has already been taken away from the general practitioner, and it is time that we look at things medical from his point of view. If, however, this operation is to be confined to cases that cannot be reduced by simple methods and held by ordinary immobilization, that is all right. After one has tried conservative methods and does not succeed, it is time to devise various other means of reducing the fracture and keeping it; but before that, there is no reason to open avenues of infection and also add burdens to the already overburdened and underpaid general practitioner.

Dr. Roland Hammond, Providence, R. I.: I am one of those orthopedic surgeons who are still using the weight and pulley in the treatment of fractures in the shaft of the femur and, at times, in the shaft of the humerus; and when a fracture with a number of inches of overlapping can be brought down to position and held there, as shown by the Roentgen ray, I shall continue to use that method in such cases. It usually does not involve the use of ether, and I feel that when a fracture is once in position it is easy to hold it there.

Dr. A. A. Crane, Waterbury, Conn.: It is a tremendous relief to me to hear from the gentleman from Providence that there is one old fogy still ignorant enough to use weight and pulley traction. I thought that I was the only one left. I was in France last summer and saw that there were some old fogies left there. For instance, Dr. Joseph Blake was using that method entirely. Dr. H. H. M. Lyle and Dr. Joseph Marshall Flint also used it. It is considered over there as the type of American surgical treatment. French army surgeons are detailed by their government to study these methods and adopt them. By the method of suspension and traction by weights, springs and pulleys, as carried out by Dr. Blake, adjustment in every direction is possible.

Dr. Ridlon said that we do not know when the fracture is set. They do over there. The results are all verified by the fluoroscope. There may be cases in which this line of treatment cannot be carried out, but it applies to most cases. I used it before I went over and have done so much more since I came back.

Dr. John Ridlon, Chicago: I should like to have Dr. Crane say whether, in using that method in France, they constantly verify the position in which the fracture is maintained by means of the fluoroscope, or simply note it once.

Dr. A. A. Crane, Waterbury, Conn.: The fluoroscopic examination is made only once after the reduction is made, and again before the patient is discharged. There is no

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constant verification by means of the fluoroscope from day to day.

Dr. E. A. McCarthy, Fall River, Mass.: Dr. Allen can probably use this method with a great deal of skill. I believe, however, that the indiscriminate use of this method by practitioners throughout the country would probably not result in a great deal of benefit on account of its complicated character. As to traction in the reduction of fractures, most men of the present day, I believe, are convinced that traction in the case of a fracture of the femur is passé as compared with the operative procedure in uniting fragments. The patient, himself, on traction for a long time in a reclining position, is a big factor to be considered. In the cases that I have seen and reduced by the open method, it has been possible in many to hold the fragments together without the aid of foreign material. Plaster-of-Paris has been applied after the wound has been sutured. Exceptionally good results have followed this method.

Dr. Samuel C. Baldwin, Salt Lake City: The more orthopedic men get to using operative procedures in the treatment of fractures, the less cases of fracture they are likely to get to treat. People do not want to undergo an operation if they can help it.

With regard to the weight and pulley, I would say that there is unquestionably no doubt that a man may lift himself up by his hamstrings, but how many seconds can he hold himself there? A weight attached to the lower portion of the limb, if kept on long enough, will tire out the muscles, allowing extension to be complete; and in a large proportion of cases this will prevent overlapping of the fragments and permit of apposition. Recently a physician in Pittsburgh told me that he was going to operate in a case of fracture of the tibia at the patient's home, because he could not get the patient to go to the hospital. I asked him how much weight he was going to use, and he replied, "Twelve or fourteen pounds." I said, "Put forty pounds on." He did this and the next day it was down. Notwithstanding Dr. Ridlon's statement that he does not know any orthopedic man who follows weight and pulley traction, I believe that nine-tenths of them are doing it; and the more of them that are doing it intelligently, the better the results.

Dr. Melvin S. Henderson, Rochester, Minn.: I should like to emphasize what Dr. Freiberg has said. We have heard Dr. Allen talk of his method for several years, and while it is exceedingly interesting, I fail to see any new mechanical principles; but the main objection to it is that as an operative procedure it complicates the operative field and adds another avenue for the entrance of infection. If Dr. Allen would show us statistics to prove the good effects of the method I am sure that we should all be delighted.

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Dr. H. R. Allen, Indianapolis: I do not use a constant force under any conditions requiring fixation energy. Buck's extension is usually associated with a weight and pulley, and I have tried to make it clear that I do not use a constant force when I am trying to secure a constant distance; and you will surely recall from your childhood the unaltered statement in your primer that the force that operates the pulley is the force of gravity which is a constant force, and all primers agree on this point. Bones unite as they are held. It is therefore up to us to hold them straight and in a constant position.

It is disheartening to present this topic to a man of Dr. Freiberg's attainments for several years and find at the end of that time he is unable to discuss the paper. We are supposed to be dealing with the abstract subject of "mechanical principles" which cannot be Roentgen rayed. We are trying to put orthopedics on a sound and unassailable mechanical basis, and to present Roentgen-ray pictures or other diverting and irrelevant matter would merely confuse the purpose of this paper. It is only fair to add that the application of sound and appropriate mechanical principles will produce most gratifying roentgenograms of united bones.

At every meeting I am asked for the formula of this alloy. It contains 50 per cent. lead, 25 per cent. tin, 12.5 per cent. cadmium and 12.5 per cent. bismuth. The wire loop stabilizers are not through and through devices. I have seen real pus accumulate about them and flow out over the skin without one degree of temperature rise. They are so constructed as to provide sufficient outlet from their base out.

I am very glad that Dr. Ryerson has called attention to the possibility of establishing crutch paralysis by using the splint for fractures of the humerus. Like any crutch made on the nonrigid straplike plan there is less danger of crutch paralysis than with the rigid type of crutch. But it must be remembered that any crutch paralysis also depends on a prolonged and a considerable degree of pressure which is never necessary in this system of treatment for the following reasons.

In the first place there is little or no traction necessary to hold broken bones in their proper place after they have once been pulled down to their proper place. For twenty-five years I have worked diligently on the application of mechanical principles to surgical procedures and I want above all else to have orthopedic surgery put on a sound dynamic basis, since it represents the mechanical division of all medicine and surgery and it should be unassailable in its very foundation. Not one has come out and attempted to discuss the basic principles I have come to present to you. There is not one who can logically account for the basic mechanical principles that he uses every day.

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A REPORT OF A GROUP OF ONE HUNDRED AND TEN CASES OF POLIOMYELITIS

FROM THE ACUTE ONSET TO THE PRESENT TIME

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The group of 110 cases of poliomyelitis on which this report is based, with fifteen additional cases, represents the result of the study of an epidemic in a suburb of 35,000 inhabitants of New York City during the summer of 1916. These 110 cases were all isolated in hospital accommodations where each patient could be continuously observed.

The origin of the disease in this community was definitely traced through a carrier coming from an infected household in Brooklyn. The district first infected was an Italian community, in which particular section forty-two cases developed. This community was somewhat crowded, although in a comparatively clean neighborhood.

The first case developed on July 13 and the last one on Oct. 25, 1916. No other cases have developed from that time up to the present date.

Early Diagnosis.—The majority of the cases were somewhat similar and developed as follows: The child was said to have been sick from one to four days with fever, usually vomited and frequently gave a history of pain in the head, neck, back or extremity. On examination, the child was found to be lying on its side, with the head thrown back, quiet or asleep. When aroused it was usually irritable. In 81 per cent. of the cases there was stiffness of the neck.

Other evidences of the disease were found to be an abnormal condition of the knee jerk, and dis-

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turbances of reflexes throughout. In addition to these clinical findings, the diagnosis was corroborated by a spinal fluid examination. These specimens were all examined at the von Wedel Laboratory of the New Rochelle Hospital, and the diagnosis was confirmed in many doubtful cases by this examination. A lumbar puncture was made in eighty-two cases.

One course of the disease frequently seen was that in which the child was sick for a day or two and then apparently better, being allowed to get out of bed, after which the fever returned and the typical symptoms developed. It may be here remarked that there was but one case resembling the classical picture so often described in textbooks, of the child going to bed perfectly well, taken ill during the night and found to be paralyzed in the morning.

There were twenty-five cases of suspected poliomyelitis in which the spinal fluid gave negative findings. In each instance, the cell count was under 20. The fluid was normal, Fehling's always unreduced. The fluid was always clear, and there was no increase in albumin or globulin. In none of these twenty-five suspected cases of poliomyelitis giving negative spinal fluid findings did poliomyelitis subsequently develop. On the other hand, in none of the cases in which the spinal fluid gave positive findings was a mistaken diagnosis made — all developed poliomyelitis. From these data, it is fair to assume that a definite early diagnosis can be made by carefully studying the clinical symptoms in conjunction with the laboratory findings of the spinal fluid.

During the first week nineteen patients were admitted to the hospital. In one month there had been eighty-one patients admitted. By October 25, 110 patients had been admitted, the time of detention in each case being not less than six weeks. There were fifty-six male patients, or 50.9 per cent., and fifty-four female patients, or 49.1 per cent. There were only three colored children, or 2.7 per cent.

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This is undoubtedly due to the fact that a small proportion of the population are colored people.

The ages varied from 2½ months to 45 years. Those patients under 5 years numbered eighty-five, or 77.3 per cent.; from 5 to 10 years of age, fourteen, or 12.7 per cent.; from 10 to 15 years, eight, or 7.3 per cent.; over 15 years, three, or 2.7 per cent.

It is interesting to note that in eight families there was more than one case. Also, that the houses having more than one case, not in the same family, were six in number, so that no fewer than seventeen cases of the disease might be assumed to have been contracted from other members in the same house, a percentage of 14.5.

On further study of this subject, however, we learn that in but six of these seventeen cases did a sufficiently long period elapse to justify the conclusion that the disease was contracted from other members of the same household, as explained in the accompanying table.

CASES OCCURRING IN SAME HOUSEHOLD

Name	Date of Onset	Name	Date of Onset
J. C.	July 24	B. T.	September 4
T. C.	July 26	S. G.	July 18
J. H.	July 27	M. M.	July 18
P. H.	September 8	J. P.	July 19
P. F.	August 9	A. P.	August 1
T. F.	August 10	M. D.	August 3
J. P.	August 9	D. C.	July 21
I. P.	August 10	A. L.	July 26
G. P.	August 17	F. O.	August 5
J. H.	August 24	W. D.	August 7
A. H.	August 26	R. H.	July 31
E. N.	August 11	W. S.	July 31
H. N.	August 14	R. T.	August 10
D. S.	August 15	H. S.	August 4
F. S.	August 21	M. H.	August 15
I. T.	August 26		

In one family three out of seven children contracted the disease, two of whom died. In another family, two of three children developed the disease. In another, two out of five and in a fourth family, two out of four children. In a fifth family, two out of

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six children, and in two other families both of the children in each family were affected.

Of houses in which more than one case occurred not in the same family (tenement and two family houses) there were three cases each in two houses and two cases each in three houses. This gives us a total of twenty-nine cases, or 26 per cent., all of which were associated with one or more cases in the same family or house.

Paralysis.—Paralysis occurred within the first few days of the disease. The average time of the onset of the paralysis was the fourth day. The percentage of paralyzed and nonparalyzed patients was from fifty-eight to forty-two. The day on which the largest number of cases of paralysis occurred was the third day. The result of my observations led me to expect a recovery without paralysis, if the patient showed no signs of it within the first eight days of the disease.

It is of interest to note that eight patients in whom facial paralysis developed had no other paralytic involvement, and but two of the other paralyzed patients had facial involvement. Deducting the patients who died, 55 per cent. of the paralyses involved the lower extremities.

In studying the relation of the paralysis, both in degree and extent, to the cell count in the spinal fluid, I found that there is nothing to indicate either the type, degree or extent of paralysis by this means. In some cases, in which the paralysis was very extensive, the cell count was low, as in Case 2, cell count 43; Case 5, cell count 80; Case 7, cell count 65. In cases in which the paralysis was nil, the cell count was high, as in Case 46, cell count 265; Case 83, cell count 380; Case 84, cell count 392; Case 91, cell count 880; Case 107, cell count 1,160. In taking an average of the cell count, I have found that it did not average as high in the paralyzed as in the nonparalyzed patients.

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It may also be here stated that the degree of temperature in no way indicates the amount of paralysis which may or may not follow.

It was occasionally noted that shortly after admission the child would become quite rigid with tetanic spasms. These patients recovered without paralysis.

Deaths.—There were nineteen deaths, or 17.3 per cent. One of these patients died of bronchopneumonia on the twenty-third day of illness. With the exception of two other patients, all died within the first five days of the disease, so that I learned to look for recovery, provided the child did not die within the first few days of the acute attack.

A large majority of the patients died from respiratory paralysis. With one exception stupor set in early, the temperature running from 102 to 105 F. The majority of the patients, also, had difficulty in swallowing — involvement of the glossopharyngeal nerve. Stupor and inability to swallow were invariably looked on as precursors of death.

Immunized Serum.—Fifteen patients were treated with immunized serum. Administration was begun in each patient at the onset of the disease (the first to third day). Two groups of cases were selected for treatment; namely, the first, the nonparalyzed patients with but mild symptoms, the other, the severely affected patients. Seven were selected for the first group, eight for the second.

Of the seven nonparalyzed patients, but one subsequently developed paralysis. It was at first thought that this case was rather promising and that the serum in all probability had been a factor in preventing paralysis from occurring in the other six cases. In this relation, however, in studying twenty-nine other patients who were not paralyzed and who did not receive serum, only five developed paralysis subsequently. This percentage is practically the same as might have been expected had serum been used, so that I feel justified in concluding that the administra-

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tion of serum in the nonparalyzed patients does not materially affect the prognosis. In the eight severely prostrated patients, six died, and of the two who recovered, one gradually became more severely paralyzed, the other recovered without paralysis. It is very doubtful, therefore, that serum affected in any way these severely paralyzed patients.

Epinephrin.—This was administered in three patients without any apparent beneficial effect.

After-Care.—All the patients, without exception, on their discharge from the hospital were referred directly to an orthopedic clinic which was organized specifically for this purpose. To this immediate and continuous supervision and treatment I attribute in great part the excellent results which are now being obtained. The plaster of Paris fixation splints which were used in the hospital have been continued in the clinic with the same object in view.

That which has most impressed me in regard to the recovery from paralyses is the fact that long continued rest extending, if possible, over six months' duration in a light fixation splint, such as a posterior plaster of Paris shell, has been the one greatest factor in obtaining the best results.

Massage was begun within two months after the acute onset. It was soon learned that patients so treated did not do as well as those in which the massage was postponed until the third or fourth month.

The greatest difficulty has been to keep the limb at perfect rest after it has recovered sufficiently to allow the child to get about. In those cases in which it has been practically impossible to keep the children off their feet, light, carefully adjusted braces have been supplied. These braces have been furnished simply to prevent deformity in carrying the body weight. Overfatigue in these cases has been noted time and time again, with resultant arrest of progress in the return of function.

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In paralysis of the deltoid, I have found the most convenient and comfortable brace to be that of a plaster of Paris splint molded to the side of the chest and extending out at right angles to support the arm. This is bandaged to the body and has proved a practical application.

Muscle Testing by the Balance Weight.—At first, I regarded this measure with a good deal of scepticism. My opinion, however, has now changed since I have learned that in patients on whom it can be applied, the physician will have a much more definite knowledge of the progress of the case and can then more intelligently advise regarding muscular activities. I have in several instances, for example, passed opinion on the extent of the progress of a case by an ordinary manual examination, after which muscle testing by the balance weight having been made, I have recognized decided errors which otherwise it would not have been possible to check up.

A large majority of the patients affected, namely 77 per cent., were under 5 years of age. This necessarily eliminated all but 23 per cent. of the patients, some of whom were not paralyzed, and other of whom died, leaving a small minority of patients in whom muscle testing by the balance weight was applicable. This muscle testing should be made by the same individual each time in order to be accurate.

Muscle Training Exercise.—The exercises have been attempted in all the patients. My experience has been that these exercises are of great value when they can be closely supervised by both the physician and nurse. When, however, this supervision must be left in great part with the parent, the results are not nearly as good, although it may be said that they appear to be better than would be expected if no such muscle exercises were undertaken. I have not employed electrical currents of any kind in the treatment of any of these patients.

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Bath Exercises.—A method which I have found to be of great advantage, both in examination and in muscle training exercises, has been bath exercises. For this purpose, I have had installed in our clinic a bath 4 feet by 3 feet. In this bath, the slightest response of returning power in a muscle or group of muscles can be detected and recorded. In addition to this, the patient is encouraged to attempt and obtain motion which would otherwise be impossible — and this without the slightest overfatigue.

Thirty patients have been discharged from our clinic, having completely recovered and being in need of no further supervision. This number represents 33 per cent. of all the patients, exclusive of those who died. To these, I may add another 26 per cent. who will in all probability be discharged as cured within six months' time. This leaves 41 per cent. who will require further treatment. Of these patients, 26 per cent. are able to walk comfortably, but 15 per cent. are unable to do so. Of this 15 per cent., however, one half of the patients are 2 years old or under; which accounts in part for their disability.

CONCLUSIONS

1. A reliable early diagnosis can be made in a large majority of the cases.

2. We are unable to prognosticate regarding the subsequent severity of the paralysis, either by the acuteness of the febrile stage or any laboratory findings thus far submitted.

3. When death occurs, it takes place with few exceptions during the first few days following the acute onset.

4. Treatment outdoors during the convalescent stage is most beneficial.

5. In my experience, immunized serum treatment has not proved efficient.

6. Although there is nothing to disprove the possibility of an insect carrier, the evidence herewith sub-

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mitted would sustain the assumption that poliomyelitis is a contagious disease.

7. Although muscle testing by balance weight is applicable in only a small percentage of the patients, in these patients it is of much value.

8. Continuous supervision is most important.

9. Continued electrical treatment is not essential for the recovery of lost muscle function.

10. Bath exercises in relation to muscle training form one of the most practical and useful lines of treatment that can be followed out.

11. Complete rest extending over six months is one of the most important factors in obtaining perfect return of function.

12. Overfatigue is of the greatest detriment to improvement, and is most difficult to guard against.

13. Braces should be made as light as possible and should be supplied immediately when body weight-bearing tends to produce strain or deformity.

14. The percentage of paralyzed and nonparalyzed patients in an epidemic may be expected to be about 58 per cent. paralyzed, 42 per cent. nonparalyzed; or, excluding those who died, 49 per cent. paralyzed, and 51 per cent. nonparalyzed.

I wish to express my indebtedness to Drs. A. W. Hoyt, H. W. Titus, Fairfax Hall and B. F. Drake, all of whom have been associated with me in the case of these patients.

40 East Forty-First Street.

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THE ORTHOPEDIC TREATMENT OF ACUTE AND CONVALESCENT POLIOMYELITIS

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So much has been written during the past year of poliomyelitis that one naturally hesitates to add to the literature on the subject; and yet the feeling of certainty that the problem is much bigger than anything so far written or said, and the hope that out of our experiences at the Seaside Hospital there may come a little help in the efforts to meet the challenge of this terrible disease, impel me to briefly report the results of the work done in that institution. It is, of course, to be understood that this is a preliminary report only.

I feel quite confident that soon the questions of specific agency and the mode of transmission of the disease will be settled, but so far orthopedic surgery is the one branch of medicine that has contributed something definite to the problem of curing crippled and deformed children. Out of the maze of uncertainty and wild theories, one fact stands out clearly: We have prevented and corrected deformities, and we have hastened the restoration of muscle power.

That is good, but the time has now come, if we are to be of the most service to humanity, for us thoroughly to recognize the fact that a large percentage of the deformities that heretofore have given us the opportunity of appearing in the more spectacular rôle of operative surgeons would not have occurred if the proper treatment had been carried out in the acute and subacute stages. Clever operations designed to

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correct deformities is not enough; we must prevent these deformities; and what is of vastly more importance, we must prevent permanent paralyses.

We must not be satisfied when in one, two or three years, by our muscle reeducation, we have opened up new paths of conduction and thus brought about a partial or complete restoration of muscle power. We must so treat the child in the acute stage that the normal paths of nerve conduction will not be destroyed.

While the major part of this paper is a report of the work done at the Seaside Hospital in the treatment of the disease in what is known as the convalescent stage, I feel that by far the most important thing I can do is to insist on a plan of treatment of the acute stage which I think will render much of this tedious and uncertain work unnecessary.

I wish to observe, first, that the division of the ordinary spinal type of the disease into the acute, convalescent and chronic stages is not sufficiently accurate and does not correctly correspond with either the pathology or the clinical course of the disease. Rather, it seems to me that a better division would be into acute, subacute, convalescent and chronic stages. If I were obliged to make an arbitrary time division of these stages, I should say that the acute stage covers the first four weeks and corresponds to the active inflammatory process in the cord, and lasts until the cells that have been disabled by effusion have recovered. The subacute stage begins at the fifth week and extends to the time when the cells that have been disabled by light hemorrhage have cleared up. This I should place at the end of four months. The convalescent stage begins at the fifth month and extends to the time when the motor cells that have been disabled by deep hemorrhage have recovered. This I should place at the end of two years. The chronic stage begins at the third year and represents the permanent paralyses of muscles receiving their nerve supply from the motor cells destroyed by toxemia.

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A knowledge of the pathology of the disease and of the physiology of the nervous system would seem to indicate that the proper treatment of the acute stage is the inhibition of afferent impulses to the sensory cells of the central nervous system, thus making it impossible for the diseased motor cells in the anterior horn of the cord to be stimulated through the reflex arc. A motor cell that is diseased through effusion or hemorrhage should receive the same rest that we attempt to produce in any other diseased structure. To produce this motor cell rest it is not sufficient to inhibit the afferent impulse from the muscles involved or even of the member involved. All afferent impulses from the entire body, those arising from the surface of the body as well as from the deeper structures, should be checked. There can be no question that cells which are disabled by effusion and which should resume their function by the end of the acute stage, if they receive the proper rest, are hindered in their recovery and further disabled by attempts to functionate. And in the same manner cells which are disabled by light hemorrhage and which should resume their function by the end of the subacute stage are further diseased by use and converted into the more seriously diseased type of cell.

I think it is agreed that the cells destroyed by toxemia form a small percentage of the cells affected, probably not over 10 or 12 per cent., and yet we have had permanent paralyses vastly in excess of that. What does that mean? It means simply that by our lack of understanding of the conditions present and the indications to be met, we, by our meddlesome efforts to assist Nature, as we think, are pouring impulses, or allowing them to be poured, into a diseased cell that has its outlet blocked, thus either destroying it entirely or converting it into a more seriously diseased condition. Any end-result that carries a permanent paralysis in excess of the cells

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destroyed by toxemia is a sad commentary on our treatment or lack of treatment. Early in the work at the Seaside Hospital in treating the disease in the subacute stage, we proved to our entire satisfaction the beneficial results following complete immobilization of the entire body. I am quite sure that the results will be even more striking if this plan of motor cell rest is applied in the acute period. Our method of obtaining this result in the subacute stage was by encasing the child in a plaster bed, separated so that it could be removed if necessary. It was really remarkable how comfortable it was to the patient and how much struggling and fear it overcame. I have not had a large opportunity of using the method in the acute stage, but in the future if the chance should come, I shall treat every child, as soon as the diagnosis is certain, by immobilization in a plaster bed, putting it in a dark, quiet room, covering the ears to keep out all sounds, and with a careful attention to diet and excreta.

CONVALESCENT STAGE

Seaside Hospital was opened, Sept. 18, 1916, for the hospital after-care treatment of the disease. It grew out of the desire of the "Brooklyn Children's Aid Society" and some public spirited men to help meet

TABLE 1.—RESULTS IN ONE HUNDRED AND FORTY-SIX CASES

	No.
Discharged wearing braces and practically recovered	5
Left within a day or two of admission	5
Here too short a time to be included in an estimate of our results	10
Cases in hospital long enough to be included in our estimate	112
Cases of the encephalitic type—"spastics"	14

the emergency that followed the epidemic of last summer, and the desire of Dr. Truslow and myself to put into practice some ideas we had as to the proper treatment of the disease, chief of which was the firm belief that in the seriously paralyzed children the treatment should be hospital rather than home or dispensary. There have been admitted to date 146 children, all seriously paralyzed. Twenty-four of these at admis-

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sion were still in what we consider the subacute stage. It is worthy of note that these have made a more satisfactory improvement than those admitted later in the course of the disease.

In the list of cases in Table 2 it should be particularly noted that we had no case of hemiplegia, though we have had three cases with the arm of one side and the opposite leg paralyzed.

TABLE 2.—DISTRIBUTION OF PARALYSES	No.
Paralysis of one arm	7
Paralysis of both arms	6
Paralysis of one leg	14
Paralysis of both legs (paraplegia)	68
Paralysis of one side (hemiplegia)	0
Completely paralyzed (both arms, both legs, back, abdomen, neck and chest)	17
Paralysis of one side of face	2
Paralysis of speech center (one has perfectly recovered, one just beginning to say a few words)	2
Backs involved	86
Backs involved, with marked curve	42
Abdomens involved	66
Abdomens involved, with large globular bulging of some part of wall	7
Paralysis of sphincters	5

TABLE 3.—DEGREE OF IMPROVEMENT	No.
Very great improvement	64
Fair improvement	42
No improvement as yet	5
Died, from pneumonia	1
Abdomens improved	61
Of these very great improvement in	5
Abdomens unimproved as yet	5
Backs improved	86
Of these, very great improvement in	8
Of the 14 spastic cases:	
Improved	8
No improvement as yet	4
Died, both from pneumonia	2

On admission, the child is carefully examined and the condition of every muscle thus recorded on the history chart:

N, normal.

—1, weak, but can lift and sustain moving segment against gravity.

—2, can lift but cannot sustain moving segment against gravity.

—3, cannot lift moving segment but can assist.

—4, cannot assist, but examining fingers feel response in tendon.

—5, completely paralyzed.

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Table 4 shows the present condition of some of the more important muscles that were marked — 5 on admission.

It will be noted that of these important muscles we have had the most marked improvement in the deltoids and the least improvement in the quadriceps. The same rule we have found to hold in the case of these same muscles marked less than —5 on admission. We feel particularly gratified in the improvement we have had in the deltoids. In this connection we have found that all the muscles of the shoulder recover in about the same degree as the deltoids with the exception that the external rotators, supraspinatus, infraspinatus and teres minor, seem to be slower. This fact will be noted later. Of forty-six paralyzed shoulders, thirty-two of which are noted in Table 4 as —5 deltoids, all but two already show a marked improvement, and we feel quite sure eventually will be useful joints.

TREATMENT

I have already discussed the problem of the treatment of the acute stage. I repeat that the bringing about of a condition of motor cell rest is the thing to be desired. If better methods than I have indicated can be thought of, they should be used. However it is brought about, I am quite sure that it will mark the most important advance made in the treatment so far, and will save many children from the crippling and deforming results that heretofore have attended the disease.

In the subacute stage the treatment is rest and support of paralyzed muscles and the prevention of deformities. The same general rules are to be followed as in the treatment of the convalescent stage, with one exception.

In discussing the treatment of the convalescent stage, which is the work that has occupied practically all of our time, the treatment followed and some of our more important conclusions are so related that it

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TABLE 4.—PRESENT CONDITION OF MUSCLES MARKED MINUS 5 ON ADMISSION

Muscle	Number	Improved from —5 to —4	Improved from —5 to —3	Improved from —5 to —2	—5 to N	Unimproved as Yet
Deltoids	32	8	8	10	4	2
Glutei	69	24	19	9	9	8
Hip flexors	64	13	23	11	12	5
Quadriceps	84	19	27	20	8	10
Hamstrings	71	20	19	14	10	8
Gastrocnemius	16	6	2	3	2	3

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is impossible to discuss them separately. I wish to observe that:

1. The most frequent paralyses, in the order named, are anterior foot muscles, quadriceps, glutei, hamstrings, deltoids, hip flexors, internal rotators of the thigh, and external rotators of the shoulder.

2. The treatment of the spastic cases is most unsatisfactory so far, but rest is indicated. We have found that attempts at massage and muscle training are neither agreeable nor beneficial.

3. A stretched muscle will not regain its tone. This is very important and is the key to all treatment. Every weakened muscle, the dorsal flexors of the ankle, the quadriceps, the deltoids, or the muscles of the back and abdomen should be treated with this fact kept in mind. We attribute our results in the treatment of deltoids to the fact that the muscle has been kept in a relaxed position continually. This we have done with a brace that elevates, externally rotates, and abducts the arm. Whether the elbow is extended or flexed depends on the condition of the biceps and triceps.

4. Many muscles marked —5 on admission have been found to be cases of muscle fatigue and not true paralysis. This we have proved time and time again in the case of feet that have been in a position of valgus for four or five months. After putting the foot up in plaster for two or three weeks in position of marked dorsal flexion and inversion and then removing the cast, we have been surprised to find very good anterior and posterior tibial muscles.

5. Contrary to the plan of getting the children up as soon as possible we have followed the opposite course. We are convinced that many backs are injured because the child is put in braces and encouraged to walk. Even though some particular muscle or set of muscles can be braced sufficiently to allow the child to walk, it should not be done until it can be done without injury

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to other weakened parts. The effort should be to bring about a symmetrically recovered whole. If the child receives the proper massage and muscle training treatment, prolonged rest in bed can do no possible harm.

6. The treatment is hospital rather than home or dispensary. It is impossible to carry out the treatment that follows an appreciation of the law that a stretched muscle will not regain its tone by taking the child to a dispensary every other day. Casts will be loosened, braces will be allowed to slip and supports will need readjusting even with the most frequent watching.

If we have had any superior results in our work, it is not that we are more capable orthopedists than others or that our muscle trainers are more skilful than others; it simply represents the superiority of hospital treatment over any other plan that does not give the same careful and constant attention to details.

7. Electricity has no place in the treatment of the disease before the chronic stage, and even then we question its benefits.

8. Muscle training or muscle reeducation is very valuable in the convalescent and in the chronic stages, but not indicated in either the acute or subacute stages. It is illogical to attempt to build a new communicating line from brain to muscle while the probability remains that the old line will do the work. This is the one exception we noted in speaking of the treatment of the subacute stage. It may do harm if used early in the disease by stimulating the diseased motor cells that require rest to bring about their recovery.

9. A reference to our statistics will show that out of 112 cases, eighty-six showed a very weakened condition of the back muscles, and forty-two presented a decided curve. We feel quite sure that poliomyelitis, either frank or unrecognized, furnishes us the reason for most of our cases of scoliosis. We do not feel that

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faulty posture alone causes scoliosis. It may be the exciting cause, but in our opinion a careful examination into the history of the case will disclose the fact that there has been a predisposing cause, and with the exception of those cases caused by empyema, rickets or asymmetry, we believe this predisposing cause will be found to be due to a disturbed relationship between the muscles of the back from a previous attack of poliomyelitis. In speaking of the treatment I have attempted to state general principles rather than to give bare statistics.

CONCLUSION

I wish to repeat, as emphatically as possible, these two points:

1. Treatment of the acute stage should have in view the bringing about of a condition of motor cell rest.

2. All treatment of weakened or paralyzed muscles, in whatever part of the body they may be, should be based on the law that a stretched muscle will not regain its tone, and methods and appliances used that will keep the muscles in a position of constant relaxation.

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TREATMENT OF ANTERIOR POLIOMYELITIS AT FORDHAM HOSPITAL

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The recent epidemic of anterior poliomyelitis in this city with the tremendous number of unfortunate victims put a special task on the general hospitals in which orthopedic clinics are held. At the regular orthopedic hospitals, there was no need for making special preparations for treating the anterior poliomyelitic patients from this epidemic during the convalescent stage, for they always had such cases. The general hospitals, while they had orthopedic clinics, had to make special provisions to meet the vastly increased demands. As we had such a problem in Fordham Hospital, I will first review briefly the provisions made here.

FACILITIES AT FORDHAM HOSPITAL

There was no adequate room in the hospital to spare for administering treatments to these patients, but we had plenty of ground facing the Bronx Park. We constructed a large tent with a wooden floor and steam pipes (Fig. 1). The location of the tent outside of the hospital helped also to avoid the interference of these small cripples while passing through the general dispensary rooms. The advantage of a tent in summer need not be elaborated on but, even in winter, we found that the sun shining on the canvas helped to

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warm the tent very quickly. During the entire season we missed treatments only about five times owing to the strong wind then prevailing, especially as the hospital is located on a high level surrounded by parks. We really feared the wind more than the cold. Few of the children ever caught cold in the course of the treatment. The inside of the tent is cheerful and has an excellent effect on the little children (Fig. 2). They run around and enjoy themselves and do their exercises freely.

Inside this tent we placed massage and examining tables and electrical apparatus. At one end we have special toys, large and small, for exercising the younger children and for making the time more pleasant for the older ones. Often an older child will help a younger one use the toys, and thus double benefit is derived. Such provisions, in my opinion, can be made in any general hospital on short notice.

The treatments are given by experienced masseuses and muscle educators. At least one physician, a member of the orthopedic staff, is always on duty in the tent to see that the massage and exercises are properly administered, not overdone and, if necessary, to change the orders. We have also a special social service nurse who devotes her entire time to this work.

REGULATIONS OF THE CLINIC

As orthopedic patients are in the habit of roaming from one clinic to another, and as we desired to watch the results carefully, we have established the following regulations, which proved practical:

1. No patients are permitted to attend any other orthopedic clinic during the time that they are receiving treatments at our hospital. If the social service nurse discovers that they do attend another clinic they are informed either to stay with us or to go to the other place. At the beginning, we lost many patients; namely, those who have the tendency to

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migrate to many hospitals, while the more settled stayed with us. Of course, we have somewhat the advantage that we are away from the center of the city, and thus the patients are less tempted to visit other hospitals.

2. On admission every child was carefully examined and the mother was told that the child could not be assigned to us unless she was willing to comply with our orders. The child had to be under our control and the treatments would be changed only when we considered it necessary. The distrustful mothers left us at the beginning, because of what they considered "strict discipline," while most of them realized it was for the child's welfare and remained with us.

3. Every mother had to consult the physician in charge of the tent at least once every two weeks, reporting to him then how the child was getting along at home and to receive from him further instruction. Of course, her reports were accepted with due consideration to her intelligence. At the beginning, to our surprise, some mothers were not able to see the benefit of this additional burden and had to be urged to come. Most of them, however, were so interetsed that they used to wait anxiously for their turn to consult the physician. Within a short time the mothers learned that, if they noticed no improvement and if the child complained of any trouble of an orthopedic nature, they could come to the clinic and ask the social service nurse to make an appointment for the physician to examine the child. No child was examined except in the mother's presence.

4. After the first three months, no patient was admitted to the clinic who had attended another hospital unless he was transferred to us from there, or if the Society on After Care found it necessary to transfer the patient to us. Thus practically most of our patients were with us all the time and, if transferred from another hospital, their records could be traced.

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We were also able to prevent them from coming just for examination and then returning to the previous hospitals.

5. The child was examined in the regular orthopedic clinic and then sent with the chart to the tent. There the attending physician, by consulting the chart, informed the masseuses what muscles were paralyzed and instructed them what exercises to give; thus the masseuses received personal instruction in reference to each child.

6. The mothers have not been allowed to choose the masseuse who was to treat their children. While it may be of advantage to have one masseuse treat the child all the time, as in private practice, it seems to me that for dispensary patients it is of extreme disadvantage. It causes the masseuse to be partial, leads quite often to bribery and jealousy and, besides, in the absence of that particular nurse the child is left without treatment. Our arrangement has been that all the masseuses should acquaint themselves with each patient. For that reason the physician in charge has frequently changed the masseuses to different tables.

METHODS OF TREATMENT

As far as examinations are concerned, we adhered closely to Dr. Lovett's method. Even with infants we were able, with a little patience, to isolate the group of muscles that were paralyzed. We have not found it necessary to resort to the use of electricity for diagnostic purposes. Before we started the treatments, we decided to use for the first six months massage and muscle training only and then, if necessary, to resort to electricity or, at that time, to choose cases for testing the value of electricity compared with massage and muscle training.

We have mapped out that plan for the following reasons:

1. We were in full accord with Dr. Lovett's statement that electricity was valueless and that excellent

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results might be obtained by proper massage and muscle training.

2. At the previous epidemic, I had used electricity alone and likewise in combination with massage and muscle training for a period of six months on more than a hundred children and did not see any benefit derived from the electricity.

3. The use of electricity is quite often resorted to at home by many parents without any scientific knowledge, while muscle training is usually applied by one who is competent to do the work. Even if the parents watch, they easily understand that special training is required for that kind of treatment and they will not rely on their own limited capacities. When certain exercises are shown them, they follow those with greater interest than the electrical treatment and return frequently to receive further instructions.

4. The mental condition of the youngsters is to be taken into consideration. When one comes to our tent, where from thirty to forty children of different nationalities are being treated, one seldom hears a child cry, while in some clinics, the sight of the electrical machines is enough to frighten them. This point was particularly noticed by all the social service nurses who visited our clinic.

As all the patients showed marked improvement within the first six months, we did not feel justified to experiment on them. We left to others to test the value of electricity, and we were willing to follow their records and compare with ours. Fortunately, we had a chance to reexamine six patients. They returned after three months, having left us to get electrical treatment. We found less improvement in them than in similar cases treated at our clinic.

At one time we had decided to follow Dr. Lovett's experiment in choosing one side for electricity and the other for massage and muscle training, but the mothers had become so used to the undivided atten-

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tion given to each child while using muscle training and had felt so delighted with the results, that we were certain we could retain them until the patients were cured and thus be able to report carefully on the results of the foregoing methods. Though many mothers left us at the beginning because they wanted electricity, many new patients came to us from other clinics for the sole reason that they heard we were able to obtain improvements without resorting to mysterious remedies that frighten the children.

The treatments were given three times a week. Only on rare occasions were they ordered daily for from two to three weeks in succession. If the child was very ill or home conditions bad, he was admitted to the hospital. The massage given was very light, from five to eight minutes on a limb, effleurage being used first, and then kneading, alternating with slow friction from periphery to center. We found that no child complained of the massage. If it was painful the massage was diminished. We had many patients who were previously treated elsewhere with vigorous massage and did not improve, while with light massage the pain discontinued and the improvements were rapid.

In muscle training, we followed the Wright system advocated by Dr. Lovett in his book on infantile paralysis. We found that muscle training can be applied to infants even below 2 years of age. Many infants from 13 to 14 months old could understand the order of "up," "down," "in" and "out." Some of them who were able to talk early even repeated the words as the masseuse gave the order. For some, we used toys to attract their attention. Of course, when the child showed insufficient intelligence, we gave passive motion, while at the same time repeating the orders, so that the meaning could finally be grasped.

We resorted to braces freely. Almost every shoulder patient was put in a brace, for we felt that the danger of stretching the deltoid was too great. Only

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Fig. 1.—The tent for the treatment of anterior poliomyelitis at Fordham Hospital.

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Fig. 2.—Larger view of the inside of the tent at the end of treatments.

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two children improved without the shoulder brace. There were a few for whom these were not ordered at the beginning. After from six to eight weeks we found that they did not improve as well as those who had them. At the start they had to sleep in them; then as they improved, the braces were worn only during the day, and later on during part of the day. For the lower extremities, no brace was ordered before four weeks unless a deformity was present or feared. After receiving treatments for four weeks, the child was reexamined, and in most cases it was possible then to decide whether or not the patient had improved. Sometimes we had to reexamine the patient before the braces were given. We found that the children with the braces which allowed them to walk early improved faster than those without, and that atrophy was present to a lesser degree.

We urged the proper use of the limbs and watched not to overuse them. As the mothers had to report every two weeks, we asked them particularly not to overuse the muscles. It was interesting to note that in many children with similar paralysis of both legs, when only one limb was put in a brace and the other limb used as a control, the leg with the brace improved quickly and showed less atrophy. This seems to be due to improper and excessive use of the leg without the brace. The mothers quite often begged to put a brace on the second one. In many cases the brace was removed after three or four months. It became evident that braces were helpful when only used for a short time.

ANALYSIS OF THE CASES[1]

In the first hundred cases there were forty-three male and fifty-seven female patients. The average age was 4 years, the youngest being 11 months and the oldest 18 years. Other data are given in Table 1.

1. This analysis is given to show general extent of paralysis in the first hundred cases.

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TABLE 1.—CONDITIONS PRESENT IN ONE HUNDRED CASES

Description	Number
Patients who on examination showed no deformity	7
Patients with paralysis of the face	10
Paralysis of one upper extremity	3
Paralysis of one lower extremity	26
Paralysis of face and one lower limb	1
Paralysis of face and one upper limb	1
Paralysis of spine and one lower limb	2
Paralysis of abdomen and spine	2
Paralysis of both upper limbs	1
Paralysis of both lower limbs	17
Paralysis of one upper and one lower limb	5
Paralysis of one upper and two lower limbs	5
Paralysis of one lower and two upper limbs	1
Paralysis of one upper and one lower limb, abdomen and spine	1
Paralysis of one upper and two lower limbs, abdomen and spine	1
Paralysis of two lower limbs, spine and abdomen	12
Paralysis of four limbs, spine and abdomen	5

Ten of the patients were so sick and the home conditions so bad that they were admitted to the hospital. There were a few more who needed hospital care, but the children had just returned from forced quarantine and the parents wanted to have them at home. As we were not anxious to force any of them and, seeing that they may be justified in seeking home care, we arranged to have them brought by the transportation bus of the Society of After Care of Anterior Poliomyelitic Cases.

Braces were applied to thirty patients. Deformities were not as frequent as in the previous epidemic. Most of the children, as known, were treated in the hospitals at the acute stage by orthopedists, and deformities guarded against. I had only eight cases in which contractures had to be corrected before exercises could be given and braces worn.

The results of eight months' treatment (October, 1916, to June, 1917) on the first hundred patients that were admitted to our dispensary are given in Table 2. Of the hundred only ninety patients needed treatments; the other ten were ordered to come only for observation. Of the ninety patients, twenty-one left us at the beginning, of their own accord. This, in our opinion, is the average result that one could expect in the first eight months.

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TABLE 2.—RESULTS OF TREATMENT

Condition	Number	Percent.
Patients recovered	8	11.6
Showing marked improvement	23	33⅓
Showing moderate improvement	31	44.9
Showing slight improvement	7	10.1
Patients who did not improve	None	
Patients who became worse	None	
Patients who could dispense with the braces	4	13.3
Patients still wearing braces	26	86.7

CONCLUSIONS

1. The best results can be obtained if each patient is studied individually and controlled from beginning to end. This can be done even in a clinic by taking enough interest in the children.

2. In light massage and muscle training, we have all the facilities for improving these patients without resorting to the mysterious electricity.

3. It is easier to get the assistance of the mothers when electricity is not used than when it is used.

4. The benefit derived from proper use of braces far outweighs the atrophy which it produces. They are especially useful in deltoid paralysis. Braces should be discontinued as early as possible.

5. If proper orthopedic treatments are carried out, there will be marked improvement within a short time, and deformities will be prevented.

6. The earlier the children begin to walk, the quicker they improve, provided, of course, they do not use the limbs excessively.

I wish to express my sincere thanks to Dr. J. W. Brannan, president of the Bellevue and Allied Hospitals, and Dr. G. O'Hanlon, superintendent, and his assistants, Misses Mulmgren and Meads, without whose devoted efforts the department could not be put on so strong a basis. I take the pleasure to thank my assistant, Dr. S. Brody, for his constant and efficient aid. I must also express my hearty appreciation for the valued services rendered to us by the social service department of the hospital.

529 Courtlandt Avenue.

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ABSTRACT OF DISCUSSION

ON PAPERS OF DRS. OGILVY, EBRIGHT AND BOORSTEIN

Dr. Charlton Wallace, New York: The treatment of infantile paralysis during the acute stage, in my opinion, consists in rest. Protection in plaster of Paris during the stage of pain and tenderness is essential to relieve the patient from discomfort. During that time fresh air is, I believe, a necessity, as for the tuberculous patient. Good general nursing and hygienic surroundings are also very important. Some attention should be paid, at this stage, to the bowels, in order to clear up congestion anywhere. During the apparent paralytic stage—and by this one means the stage when many muscles seem to be paralyzed—the use of braces is preferable, when intelligently applied. However, even bracing not intelligently applied is better than no bracing at all. As the patient progresses and gets around, the amount of bracing can be cut down. Braces not only help the patient to use the extremities physiologically, but also prevent contractures. If the braces are made properly, with the weight evenly distributed, and with proper joints, corresponding with the joints of the patient, the apparatus need not be cumbersome.

The bath exercise is an exceptionally good thing. It has been used for many years in our institutions. We have seen some patients who showed no power in certain muscles, but who, when put into the water, were able to demonstrate motion in these muscles. That is probably accounted for by gravity having been overcome by the water's buoyancy. If the patient displaces his weight in water, he has a little more voluntary control over muscles that are apparently not useful.

One believes that any child that has infantile paralysis should have the benefit of anything that anybody says is helpful. I therefore use massage and muscle training, which are assets. The questionable asset is electricity. Whether or not it is beneficial, no one can prove; but one can prove just as much about the beneficial effects of electricity as one can that any treatment is beneficial, for we know that all patients improve during the first year or year and a half, no matter what treatment is employed.

The prognosis, unfortunately, is the thing that the mother is most concerned about; and no one can give the prognosis of a case of infantile paralysis until a year and a half or two years have passed. Then the damage is done, and we know what muscles are going to be paralyzed.

Dr. Walter Truslow, Brooklyn: The detail of treatment is what I find of most interest. I wish to discuss the relative value of entire hospital care for these cases, dispensary control of home muscle-training treatment, and dispensary control with dispensary muscle-training treatment.

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When infantile paralysis struck New York City last summer, it was so thoroughly frightened that it made its fright known, not by falling under the load, but by doing everything possible to meet it. The more we look back over this period, the better we shall realize the debt of gratitude we owe to our health commissioner, Dr. Haven Emerson. He is entitled to thanks for having put forward the orthopedic surgeon as the one best qualified to supervise the after-care. We had 1,800 children at the Brooklyn Contagious Hospital, where we began to use protection almost from the first. Then Brooklyn had the opportunity to secure Seaside Hospital for immediate follow-up treatment of these cases. A public spirited man made it possible to treat 100 children there. I have had charge of this group. It was a wonderful opportunity. Dr. Ebright has shown the difference in the results in the children who were with us there from the first, as compared with those who came later.

We orthopedic men went into this epidemic with the great belief that we could prevent deformities; and that if we did so we should be doing much toward the permanent usefulness of the parts involved.

I do not want to be misunderstood as saying that we have not learned anything new from this epidemic; for we have, of course. But we have had the good fortune to see our previous beliefs verified to a great extent this year.

I believe that entire hospital care is the ideal method. Absolute protection is the first essential, and this, plus progressive muscle training, is the correct treatment. Nowhere else than in the hospital can this be attained. Our workshop is one of the important features of the place. The child is sent there, and the particular problem before it is attended to at once. If we sent for an elaborate brace, it would be costly; and, by the time it arrived it would not be adapted to the child's needs of that particular period. When the child recovers more we find what its need is then, and apply the apparatus adapted for it.

Dr. Henry B. Thomas, Chicago: I want to emphasize the importance of the care of the child in the acute stage, during the hospitalization period, which last summer in Chicago was five weeks. It so happens that when the cases were brought to Cook County Hospital they were properly put on the contagious side. They were, however, also seen by the orthopedists. At this time it occurred to us that it was very important to take care of the child in this early, acute stage of the disease. If a limb or the body was moved, producing pain, we thought the muscle was injured and probably the nerve, and thus the child was given less opportunity to regain the normal muscle power than if we had left the muscles quiet. We found that when the child was bathed every day, even with a sponge, and turned over once or twice a day,

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with acute pain, the result was bad. The child did not do so well as when left absolutely quiet. These children will do best without the sponge bath if in giving it there is pain. If one can get the light massage that comes from the bath treatment, and can get the child in and out from the bath, even in the acute stage, without causing pain, we believe that one secures the most delicate massage there is, from the change in pressure, and that this will help the child's musculature. We advised in some cases that the children be put on a Bradford frame, that the entire frame be immersed in the warm bath, even in the early stage. Some of our children at first had heavy woolen stockings placed on their feet, though it was August; we had in mind the chronic infantile foot in cold weather. In the early stage this is not necessary in most cases.

Dr. Willis C. Campbell, Memphis, Tenn.: It is true that we have learned nothing very new from this epidemic, but the older methods have been better systematized, and we are better able to teach the profession as a whole the necessity of early orthopedic treatment in these cases. What is most important is, of course, as we all know, the prevention of deformity; and this should be attended to as early as possible. Massage and muscle training should, of course, not be given until after all acute symptoms have subsided. I have found that individual muscle training is far superior to instruction in classes, and that the child should receive daily attention. Dr. Truslow has brought out the fact that we may obtain better results by keeping the children in the hospital for an indefinite period. This is because the children have special care and daily treatments. Prolonged rest after the onset of the condition, and long after the acute symptoms have subsided, is usually necessary. Too early walking is to be deplored. The child should be kept off his feet for six months or even a year, in order to prevent deformity. Proper braces and splints must be applied. Deformity may often be corrected without tenotomy or other surgical procedures, as late as one year after onset of paralysis, by successive casts or adjustable braces, with appreciable return of power to the overstretched muscles, as well as restoration of proper mechanical balance.

Dr. Jefferson D. Griffith, Kansas City, Mo.: May I ask the gentlemen in closing the discussion to tell the temperature curve on the initiation of this disease, and also the blood count in this condition? The reason I speak of this is that it seems to me that we ought to broaden out, and prevent, if possible, the bad conditions that we obtain, by learning all that we can in regard to the care of these cases. It seems to me that if we can meet other infections, such as staphylococcus and streptococcus infections, that disturb metabolic processes to the great extent that they do, we

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should be able to control poliomyelitis. In this disease we evidently have an infection. We find that many infections lead up to a condition of metabolism termed acidosis; if we could find anything that would ameliorate this condition, it would prevent death during the acute stage. We know that in a marked disturbance of metabolic processes in infections, we can, by proctoclysis of hypotonic salt, sugar, or soda solution, 8 to 10 drops to the minute, bring about a condition that will reduce the ordinary blood count—not only the leukocyte count but the polymorphonuclear count—rapidly. We may be able to reduce the results of the acute infection in this way.

Dr. Walter G. Stern, Cleveland: A topic that has many practical applications is the difficulty with which the parents and, through them, these paralyzed patients, are controlled. To me, the situation in New York in the matter of hospital and dispensary abuse is untenable. I found, in the three days that I have been here this trip, many free patients in the dispensaries who confessed to the attendance of private physicians at their homes, or to the fact that they had already that day been to two other free dispensaries for advice and treatment. I think that a charities clearing house would prevent this sort of thing and put the patients under better medical control, which Dr. Ebright demonstrates is so necessary.

Dr. Thomas of Chicago, in a paper in The Journal, said, last August, that one of the principal things in the treatment of the subacute stage was the "avoidance of fatigue"; it would be a great step forward if we could have our patients under better control and prevent their running from one dispensary to another. As it is, they go from one man, who says, "Keep the patient off his feet, because it will exercise the stronger muscles at the expense of the weaker," to another man, who says, "Keep the child on its feet as much as possible." I think that "the home control" is as important a measure of treatment as anything I have heard mentioned.

Dr. Eugene Rosamond, Memphis, Tenn.: In regard to house control of these patients, Dr. Wallace has, to my mind, given us the best hint. The general public does not know that electricity is not useful, and any man who fails to play with electricity, at least in some way, is going to lose the control of these patients, especially in the families of the well-to-do. The surgeons and general practitioners, and often specialists along all lines, will be consulted by the family; and if electricity, if massage, if anything that every one knows is not used in some way, under the careful supervision of the man in charge, we are going to lose the control of these patients. It is just as reasonable to expose an acutely inflamed, painful muscle to manipulation, massage and electricity, or anything that hurts, as it is to expose an

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acutely inflamed eye to the sun. Absolute rest for too long a time, rather than not enough time, is the keynote in the treatment of the acute condition. Later, although I am a pediatrist, I believe in turning the cases over to the orthopedists. But I just want to say that we have to do a little bit of everything, carefully supervised, so as not to injure and overfatigue an acutely inflamed muscle and nerve cell, until such time as nature can discover another way around for the nerve impulse, or can repair the damaged nerve line.

Dr. Peter Bassoe, Chicago: Apropos Dr. Ebright's remark that stretched muscle loses its tone, galvanic treatment by means of an interrupter electrode does produce contractions in flaccid, paralyzed muscles which cannot be made to shorten themselves in any other way. Hence, while admitting that we cannot expect much from electric treatment in these cases and that too much has been claimed for it in the past, yet I believe that the pendulum is now swinging too far the other way when some of the speakers deny any virtue at all to electric treatment.

Dr. Charles Ogilvy, New York: We are asked very often, not only by the laity, but also by our fellow associates in the profession, whether we have made a great deal of progress in relation to the treatment of infantile paralysis. I think we have obtained a great deal of knowledge on the subject. We are continuing to gain more. We have learned more of the benefit of rest, and emphasis has been laid on that; and we also have learned about the continuous control of the treatment. The basis of treatment is, first, prevention of deformity, and second, return of function. To these the orthopedist is particularly adapted; and it should be our work to control these cases from first to last, with the association and cooperation of others interested. We should take this responsibility, and if we do so, we shall obtain better results than heretofore in the treatment. I am sure that the results we are getting now will show that we are obtaining much better results than in previous years.

Dr. E. D. Ebright, Wichita, Kan.: As orthopedists we have been insisting all the time that the treatment of these patients should be handed over to us from the very first. I think our attitude is correct, but we owe it to our patients that our treatment should be based on a correct understanding of the pathology. Any stimulus to the muscle should be intrinsic, rather than extrinsic. I mean by that, that massage, muscle training, electricity, or any other form of stimulation from the periphery that is supposed to cause the diseased motor cells to functionate through the reflex arc, should not be attempted until the cells are sufficiently recovered to carry out their part of the reflex act without damage.

A stretched muscle does not regain its tone for two

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reasons: first, because of the trophic disturbances present, due to a continuously stretched condition, and second, because of the fact that a muscle so stretched is sending sensory impressions to the posterior horn of the cord that are in turn transmitted to the diseased cells in the anterior horn. These then attempt to functionate. What we are really doing is producing a vicious circle. That is why rest is so very important in the acute and subacute stages. These children should be constantly supervised. If you put a brace or cast on a baby, the chances are that in an hour, or even a half hour afterward, the child will have it off. If you send these children home, telling the parents to bring them back every day, they will not come back supported as they were when they left. It is impossible to keep them so unless they are constantly supervised.

Out of thirty-two deltoid paralysis cases, all but two have regained some degree of muscle power. We think that in thirty of these thirty-two deltoids we are going to have useful joints, not by putting the arms in a position in which the external rotators are on the stretch instead of the internal; the arms should be kept at more than a right angle and rotated outward to protect the external rotators.

Dr. Samuel W. Boorstein, New York: Dr. Wallace spoke of fresh air. Administering treatments in a tent instead of in a dispensary affords the children the opportunity to be in the open air for three or four hours. In encouraging walking, parents are told how many times and how often the paralyzed muscles should be used daily, and also for how long weight-bearing should be permitted. If explanation is not given to the parents, they will permit the children to walk and overuse the muscles. If one puts on braces, the children will not use their feet to excess. At the same time it has a good psychologic effect, for walking is the natural exercise for children.

With reference to hospital care, I do not think that parents can be induced to leave the child in the hospital; neither is it necessary, for home surroundings are more beneficial. The earlier we return them to the home surroundings the better, unless the home surroundings are bad or we find that our orders are not carried out at home. In that case it is better to have the children in the hospital.

With reference to daily or every other day exercises, I think that if mothers carry out the exercises at home and the children are brought to the hospital every other day, it is sufficient. Then the muscles are not overtaxed and they get exercises every day. By showing the mothers once or twice, they can give the exercises very well.

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THE TREATMENT OF DEFORMITIES OF THE SPINE CAUSED BY POLIOMYELITIS

A REPORT OF EIGHT CASES IN WHICH FUSION OPERATIONS WERE PERFORMED

RUSSELL A. HIBBS, M.D.
NEW YORK

Deformities which develop in consequence of permanent damage to the muscles of the spine from anterior poliomyelitis are among the most difficult with which the orthopedic surgeon has to deal, and I know of no means which can be depended on to prevent their progress. Plaster jackets and braces can, at best, only retard the development of deformity.

It has seemed to me practical, therefore, in such cases, to do a fusion operation on the spine exactly similar to that which has been used in the treatment of Pott's disease at the Orthopaedic Hospital since 1910.

It is my purpose to report eight cases in which this operation has been done for scoliosis. None of these patients were operated on until long after the acute attack, and obviously one would not operate at all if there were any prospect of recovery of the muscles affected. I do not think, however, it is at all necessary to wait as long as we have waited in these cases.

This operation is in every essential feature precisely the same as that performed on patients with Pott's disease. Since there seems to have been some misunderstanding of the technic of the operation, perhaps a description of it here will not be out of place.

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An incision is made directly over the spinous processes through skin, subcutaneous tissue and ligament to the tips of the spinous processes. The periosteum over each tip and the ligament between is split. The periosteum is then elevated from the bone over a part of each process in turn. As the periosteum is separated from the bone, small packings of gauze are made to prevent oozing. Separation of the periosteum is carried forward gradually until each spinous process and lamina is completely bare to the base of the transverse process. This is done in children with a blunt periosteal elevator and in adults with a sharp one, as in the latter the periosteum is more adherent.

The periosteum is then pushed from the adjacent bases of the spinous processes and the adjacent edges of the laminae to the ventral side with a small curet or a periosteal elevator. With this dissection made, the operative field is ready for any treatment of the exposed bone that is desirable. The first thing to be done is to curet the lateral articulations which lie at the base of the transverse processes and are always easily reached in children and in most adults. After this is accomplished, a small piece of bone is elevated from the laminae and turned down, its free end resting on the one next below it. The spinous processes are then partially divided, with forceps for that purpose, and broken down so that the tip of one comes in contact with the base next below it. This completes all that is necessary to do to the bone.

The periosteum and ligament which have been separated are then brought together and sutured in the center with interrupted ten day chromic catgut. The skin wound is closed with continuous ten day chromic catgut. Dressings and brace or jacket are applied.

The importance of cureting the lateral articulation is evident, as it insures a fusion of bone at that point. Turning a piece of bone down from one lamina across to the next below prevents any tissue from falling between the laminae, thus insuring their fusion, while

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the importance of the transposition of the spinous processes is obvious. With the closure of the periosteum in the center, we have practically a periosteal tube filled with fresh, healthy, bleeding bone in uninterrupted contact from one end of the operative field to the other, insuring a fusion of the lateral articulations, laminae and spinous processes.

Immediately after operation a brace or jacket is applied, maintaining as much correction as is comfortable to the patient. My own preference is a steel brace which has already been made and fitted before operation. The patient is kept in bed for eight weeks, and the brace is worn for one year.

In six of these cases there was conspicuous deformity, and such weakness in three, that the patients could not sit up unaided, much less walk. All of them have been given a much better posture, much more stability, and, it is believed, protection from a progressive increase of deformity and probably have been saved from the necessity of wearing a brace or jacket for indefinite periods.

I can see no possible disadvantage in fusing even longer segments of the spine than in these cases; in fact, I think in some it would have been better to make a longer fusion. If, as seems probable, such an operation can prevent these conspicuous deformities, it should be done in many of these cases and earlier, before such irreparable damage has taken place.

REPORT OF CASES

Case 1.—H. H., boy, aged 6, who had infantile paralysis at 11 months, was admitted to the hospital, June 20, 1914. There was loss of power in all muscles of the right thigh and leg; there was some power in the external rotators, abductors and external hamstring of the left leg, but very slight power in the calf and long flexors; there was complete loss of power in all the other muscles. Muscles in the right lumbar region of the spine were extensively involved, and there was a marked dorsolumbar curve to the right with marked rotation; the patient was unable to sit up at all without support. At the operation, June 23, 1914, a fusion was done from the

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tenth dorsal to the fourth lumbar vertebrae, both inclusive. The wound healed without complication, and there has taken place a fusion throughout the operative field, preventing any increase in deformity and increasing the stability of the spine so that sitting unaided is possible. Support was worn for one year afterward, and with braces applied to legs the patient is able to walk. Figure 1 shows the patient before operation and Figure 2 after operation.

CASE 2.—J. K., girl, aged 14, entered the hospital, April 27, 1915. She had infantile paralysis at 3½ years of age, both legs being extensively involved with conspicuous deformities and extensive involvement of the spine, permitting a right dorsolumbar curve with marked rotation. She had never been able to walk or sit up since paralysis. Figure 3 shows the position assumed by the patient on attempting to sit; even this was not possible without holding herself up by her hands. After correction of the leg deformities, a spine fusion was done, Nov. 3, 1915, extending from the eleventh dorsal to the fourth lumbar vertebrae, inclusive. Fusion is complete throughout the operative field, and she has capacity now to sit up without assistance and, while I do not believe a sufficient number of vertebrae were included in this case. at the same time the patient is immensely improved. Figure 4 was taken one year after operation; with braces on her legs, the patient is able to walk. She still wears a light steel support to her spine.

CASE 3.—C. R., boy, aged 14. had infantile paralysis at the age of 5. with extensive involvement of both legs and the spine and a dorsolumbar curve with convexity to the right and with marked rotation. January 19, a fusion operation was done from the ninth dorsal to the third lumbar, inclusive. Fusion is complete, progress of deformity stopped, and the stability of the spine much improved. Figure 5 was taken after operation. Photograph before operation was not obtainable.

CASE 4.—W. D., boy, aged 6, had infantile paralysis at 2 years of age, with extensive paralysis of both legs. The spinal group of muscles permitted a marked dorsolumbar curve to the right with rotation. The patient was admitted to the hospital, May 1, 1916. Fusion operation from the eighth dorsal to the third lumbar vertebrae, inclusive, was performed, May 19, 1916. Complete fusion was secured, with marked improvement; no progress of deformity was detected. Figures 6 and 7 show the condition before and after operation.

CASE 5.—S. S., boy, aged 6½ years, had an attack of infantile paralysis at 4 years, leaving extensive paralysis of both legs and the spine. The patient never had walked or been able to sit up. The position when the patient attempted to sit up is shown in Figure 8, taken before operation. De-

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formities of the legs were corrected and a spine fusion done, July 6, 1916, from the sixth dorsal to the third lumbar. While there has been marked improvement, evidenced by the fact that the patient can now sit without support, and with braces on his legs is able to walk, it is possible that a more extensive fusion might have been better. However, there can be no question that progress of the deformity has been checked, and improvement is marked. In such a case, of course, operation should have been performed long before such conspicuous deformity developed. Figure 9 was taken after operation.

Case 6.—J. D., boy, aged 16, had infantile paralysis at 1 year with complete paralysis of one leg, with the left spinal group affected, permitting a marked dorsolumbar curve to the left with rotation. The patient was unable to sit without assistance. Spine fusion was performed, Dec. 13, 1916, from the tenth dorsal to the third lumbar. Marked improvement in both position and stability of spine followed. In this patient, also, a spinal fusion should have been done earlier in life. Figures 10 and 11 show the condition before and after operation, respectively.

Case 7.—F. D., boy, aged 9, had infantile paralysis at 4 years, leaving an extensive paralysis of the right leg and right spinal group, permitting a dorsolumbar curve to the right with marked rotation. Spinal fusion from the seventh dorsal to the fourth lumbar was performed, July 18, 1916. Complete fusion was obtained and improvement was marked. Figures 12 and 13 show the condition before and after operation, respectively.

Case 8.—W. B., boy, aged 16, had infantile paralysis at 2 years of age. The right quadriceps, left anterior tibial and peroneal groups of muscles were affected, and also the right spinal group, permitting a right dorsolumbar curvature with marked rotation. Spine fusion was performed, Dec. 29, 1916, including the eighth dorsal to third lumbar. Fusion was complete and improvement in both positions and stability of spine resulted. Figures 14 and 15 show the condition before and after operation, respectively.

130 East Thirty-Sixth Street.

ABSTRACT OF DISCUSSION

Dr. Emil S. Geist, Minneapolis: How many vertebrae should be fixed?

Dr. Fred J. Fassett, Seattle: I think we all agree with Dr. Hibbs that it is bad for a patient to wear a body support longer than is necessary. We could go further and say that it is difficult to find any form of body support which, in a paralytic scoliosis, will do the work. I have done only the bone splinting operation. In such cases, even where the splint has firmly healed in place, it has not had the slightest

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effect on the curvature or the rotation. If any operation would control a paralytic scoliosis it would be one which produced a perfect mass of new bone about the processes. This is what the operation used by Dr. Hibbs appears to do.

Dr. John Ridlon, Chicago: I should like to have Dr. Hibbs say, if he will, why he did not make an effort to correct these spines before doing the fixative operation. These spines can be considerably, and sometimes completely, corrected; but the problem is to hold them in the corrected position. His operation would seem to be the way of holding them there; but why not do the other thing first?

Dr. Horace R. Allen, Indianapolis: From time to time there come into our practice children and adults with horrible scolioses due to injury. I have had cases in which the patient had been burned, and the resulting cicatricial tissue would pull them over, and when the scar tissue was deep there was almost no way to get them straightened. I should like Dr. Hibbs to say whether he thinks the artificial production of scar tissue on the convex side might not be of benefit by contracting and holding the spine straight. Scar tissue is inelastic, as every one knows, and if it is deep enough and properly located it will be strong enough to serve as a substantial human tissue splint, and will in a way serve as a means of holding the trunk erect. If scar tissue will produce scoliosis, it is only fair to make it serve as a means of correcting it.

Dr. John Ridlon, Chicago: Some scar tissue stretches instead of contracting, and it is not very good procedure to try to straighten a scoliotic spine by putting scar tissue on the convex side.

Dr. Albert H. Freiberg, Cincinnati: I commend what seems to me an excellently conceived procedure for these cases, and it seems to me, also, that it would be no mistake to operate in these cases earlier than has been done. I would regard this as the one exception that I might be willing to make to operating on paralytic deformities early. Whatever we may feel with regard to the relative merits of the bone grafting operation and the operation of Dr. Hibbs for Pott's disease, it seems to me that this would be the operation of choice for paralytic scoliosis, because it attacks the deformity at the periphery of the curve, which is supposed to be the chief point of merit in any fusing operation for Pott's disease. There is a large question that Dr. Hibbs will have to decide for us, and that is whether the correction he obtains will endure. It seems to me that there is abundant reason to doubt that, since there is inequality of muscular action, which will persist, presumably, as long as the child lives. It is a question whether the response to muscular pull on one side, and absence of it on the other, will not eventually cause a yielding of the vertebrae and an increase of the deformity.

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Dr. E. D. Ebright, Wichita, Kan.: For the class of cases shown, I think Dr. Hibbs' operation is a most important advance. Since last fall I have seen forty-two of these scolioses that, if they had been allowed to go on, would have become exactly the type of case represented by the worst picture shown by Dr. Hibbs. I think the necessity to do that operation, however, is a reproach to the medical profession, for these deformities can be prevented if the disease is taken in time and properly treated. As Dr. Freiberg says, the paralyses are equal on both sides. and the back is as liable to slump one way as the other. The fusion operation is much preferable to the splinting operation, which controls the spine in flexion and extension only, while this method stops side bending as well.

Dr. Walter Truslow, Brooklyn: We have watched these cases this summer and have prevented the deformity, and we have seen the strength slowly come back under protection and carefully guided muscle training. Of course, we cannot yet know the ultimate result.

Dr. James W. Sever, Boston: It is not a question of muscle training over a period of a year; it is a question of holding the corrected position in these cases by adequate apparatus over a period of ten or fifteen years. If one talks of holding them for six months or a year only, one has not the correct conception to base results on.

I was glad to hear what Dr. Ebright said, but I think that he is an optomist, especially with regard to correction of scoliosis due to infantile paralysis. If he knows of any method to prevent its increasing in infantile paralysis I should like to know it.

Dr. Russell A. Hibbs, New York: The question asked by Dr. Geist, as to how many vertebrae to fuse, I would answer by saying that it depends on the extent of the curve. In some it was only necessary to fuse five or six; and in others, as many as twelve, depending on the extent of the curve and the amount of paralysis. No one would contemplate doing the fusive operation on a child whose spine was only temporarily affected. We wait and see the amount of permanent damage done by the infection.

In answer to Dr. Freiberg's question as to the permanency of the correction of these deformities, I would say that a longer time must elapse before a definite answer can be given. My own feeling is that it may be permanent.

In answer to Dr. Ridlon's question as to whether corrective work is done before operation, it is, and should always be. I feel, however, that if a longer experience proves that a fusion operation will permanently prevent these deformities, it should be done earlier.

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Fig. 1 (Case 1).—Condition before operation.

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Fig. 2 (Case 1).—Condition after operation.

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Fig. 3 (Case 2).—Position assumed by patient on attempting to sit.

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Fig. 4 (Case 2).—Condition one year after operation.

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Fig. 5 (Case 3).—Condition after operation.

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Fig. 6 (Case 4).—Condition before operation.

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Fig. 7 (Case 4).—Condition after operation.

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Fig. 8 (Case 5).—Position assumed by patient on attempting to sit.

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Fig. 9 (Case 5).—Condition after operation.

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Fig. 10 (Case 6).—Condition before operation.

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Fig. 11 (Case 6).—Condition after operation.

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Fig. 12 (Case 7).—Condition before operation.

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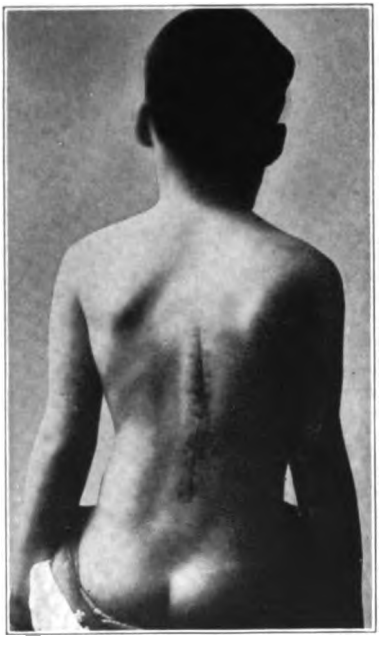

Fig. 13 (Case 7).—Condition after operation.

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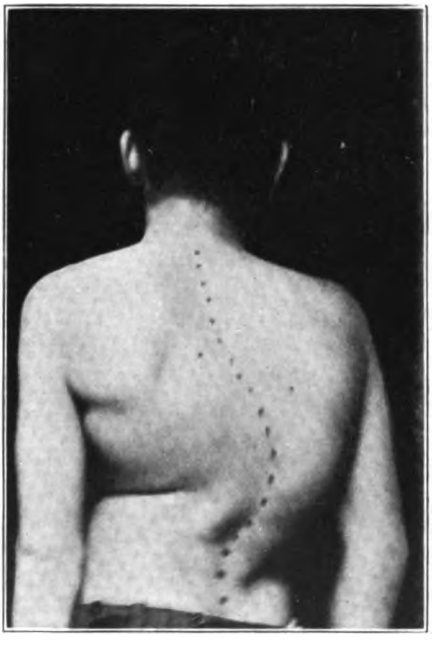

Fig. 14 (Case 8).—Condition before operation.

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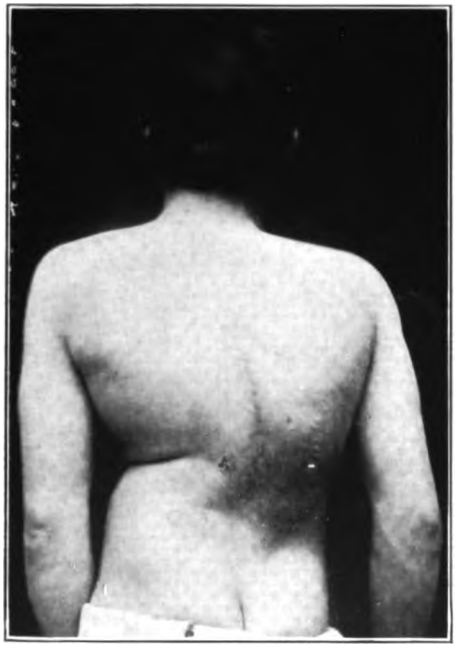

Fig. 15 (Case 8).—Condition after operation.

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THE TREATMENT OF SCOLIOSIS

FRANK E. PECKHAM, M.D.
PROVIDENCE, R. I.

From the earliest times, scoliosis has been written about and described in such a way as to make it the most complex subject in orthopedics. It would seem that if the explanations and descriptions could be reduced to simpler terms, the principles of treatment would be fewer and simpler, even though the ultimate results were still difficult of attainment. Rational treatment of any disease or abnormal condition is founded directly on etiology and pathology. In these later days, physiology is a little better known and is becoming of tremendous importance in giving a clearer understanding of many conditions.

In the first place, there must be a decision as to whether scoliosis is a deformity unaccompanied by disease of the structures involved, or whether there is a diseased condition of the bones and ligaments. My studies have convinced me that the bones and ligaments in these cases are in a softened condition, otherwise deformity of this type could not have developed. Also, it would seem to me that the term "scoliosis" should be used only to indicate a syndrome of a deformity dependent on such softened and yielding structures. I cannot agree with the idea that scoliosis is deformity without disease. There are thousands of children habitually assuming faulty positions every day, but only in the few does scoliosis develop, and in those few, the bones and ligaments are too soft to support the superincumbent body weight.

There are deformities simulating scoliosis. A child may have a short leg, thereby producing a tilting of

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the pelvis, in consequence of which curves appear in the spinal column and one shoulder is carried lower than its mate. Raising the shoe on the short leg immediately corrects the deformity, thus demonstrating the absence of the syndrome of a "deformity dependent upon softened and yielding structures."

CASE 1.—A mill girl consulted me complaining of a low shoulder and a curved spine. She had been carrying a heavy basket every day in her work and always on the same shoulder. A change of occupation was followed by a restoration to correct form. Here also there was entire absence of the syndrome. These cases, therefore, are not real scolioses, and some other nomenclature should be applied, possibly "pseudoscolioses."

CASE 2.—A young married woman with a moderate deformity of the spine presented herself with the following conditions: Her first child was 4 months old and very greedy. In this way, the strength of the mother had been much diminished. One shoulder was low, the spine was becoming curved, and there was an increasing amount of pain in the back. In other words, calcium metabolism had been interfered with. As I did not wish to apply a plaster jacket while the breasts contained milk, the advice was given to wean the baby and report for a jacket when the milk had completely disappeared. Here was a developing deformity dependent on softened and yielding structures; in other words, a scoliosis. This patient waited about three months before returning, at which time the back had completely straightened, the pain had disappeared, and the young woman presented every appearance of perfect health.

I have previously reported the case of a girl, aged 7, with a severe grade of scoliosis due to much softened bony and ligamentous structures following an attack of influenza, and another presenting the condition of hypothyroidism. Here the deformity disappeared, under the administration of thyroid extract.[1]

The foregoing cases appeal to me as representing the difference between a real scoliosis and what perhaps might be considered a pseudoscoliosis, the one without disease of the involved structures, the other with. Deformity of the spine following an infantile paralysis might be termed a paralytic scoliosis, just as, similarly, we speak of a paralytic clubfoot.

1. Peckham, F. E.: Am. Jour. Orthop. Surg., December, 1916; Rhode Island Med. Jour., January, 1917.

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If the hypothesis be accepted that scoliosis is dependent on a softened condition of the bones and ligaments, due presumably to some interference with calcium metabolism, then it seems fair to consider that it is the downward pressure of the head and body weight on this disease-weakened structure which produces the deformity. The comparison should not be with a clubfoot, but with a bow-leg or knock-knee; in other words, softened bony structures yielding to superincumbent body weight.

The etiologic factor then becomes the process which interferes with calcium metabolism. This may be rachitis, infections (including autointoxications), or the rapid growth which sometimes takes place in adolescence. The physiology of the endocrine organs is of great importance, and the thyroid gland, in particular, is supposed to preside over calcium fixation. When these physiologic processes go wrong, trouble arises.

These are some of the factors which produce a softening of the vertebrae and ligaments. These vertebrae and ligaments, yielding to the superincumbent body weight, become pushed downward and thus the deformity of scoliosis is produced. It is a scoliosis from the earliest stages. There may be different degrees of severity, both of symptoms and of deformity, but it is scoliosis all the way through. The duration of this softened condition usually extends through quite a period of time, and it is the treatment of this condition to which sufficient attention has not been given. This is pure physiology. In cases of hypothyroidism, the thyroid gland may be indicated. In the rapid growth of adolescence when there has been no scoliosis, but the symptoms have been backache and headache, swollen eyelids, the entire lack of strength and often the appearance of stupidity, the administration of thyroid extract will usually produce the desired result. One case referred to above, in which

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scoliosis was present in addition to all of these symptoms, the deformity disappeared, as illustrated in the original article. In other cases when it was uncertain what process was going on, I have used the mixed gland tablets. With more definite knowledge along these lines, much better physiologic results must be obtained.

Regarding the mechanical treatment, I have tried to make it such that these patients could continue their customary duties without interruption. Consequently some of them are attending school daily, others are working in the shops, and one stenographer is continuing her work without any difficulty. The patient is still placed face down over a curved frame (Fig. 1), so that the spine becomes lengthened and some of the curves are improved by the position alone. With the body in different degrees of flexion, rotary pulls are made, thus correcting as much as may be possible, and the patient still remain comfortable. Traction on head and feet, which was used in earlier attempts, has been omitted. It caused so much pressure on the stomach that nausea and vomiting resulted. In my work thus far, a new jacket has been applied once a month, in order to start all over again at frequent intervals, with the body in as good a position as the patient will tolerate.

Case 3.—J. S., first reported in May, 1916, is retained in plaster, as shown in Figure 2.

Case 4.—E. M., a girl, had practically attained her growth when the present method of treatment was begun. For the preceding year, other forms of jackets and braces had been tried, but the deformity was increasing, until in January, 1916, the condition was as is shown in Figure 3. Jackets have been reapplied monthly, and Figure 4 shows the condition in March, 1916. Figures 5 and 6 show the condition as late as April, 1917. She is now 19 years of age, and still improving. The last picture shows still further improvement, but came in too late for publication.

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Fig. 1.—Patient in position on frame.

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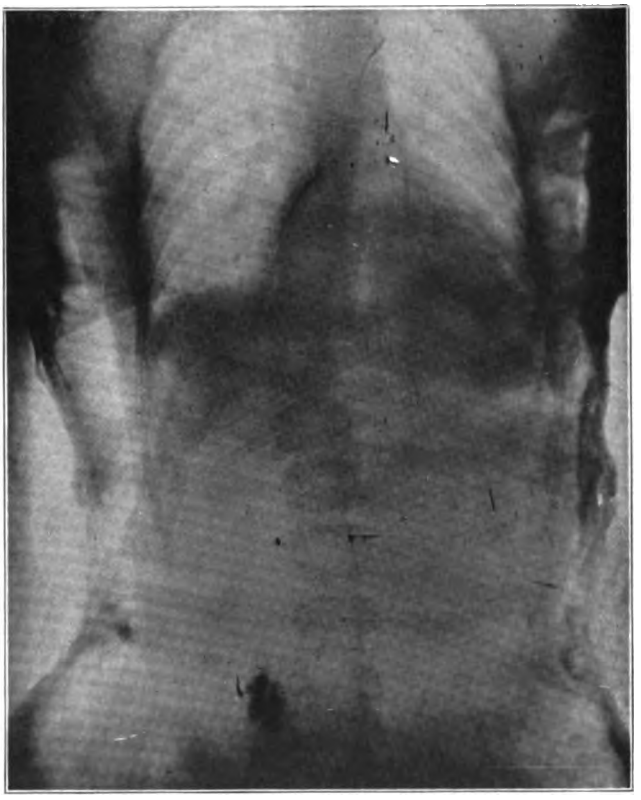

Fig. 2 (Case 3).—Condition, March 24, 1917.

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Fig. 3 (Case 4).—Spine of a girl, aged 18, before beginning the present form of jackets, Jan. 6, 1916.

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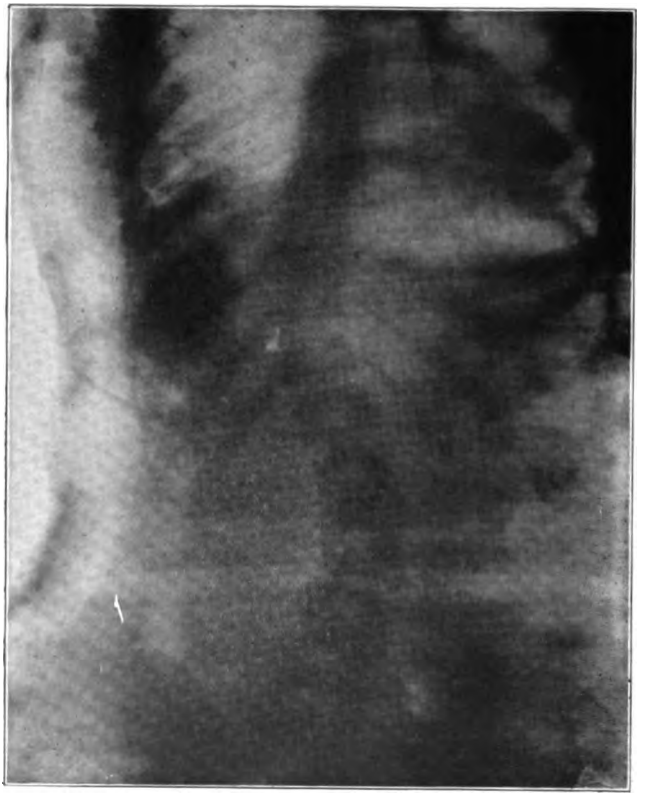

Fig. 4 (Case 4).—March, 1916; second jacket.

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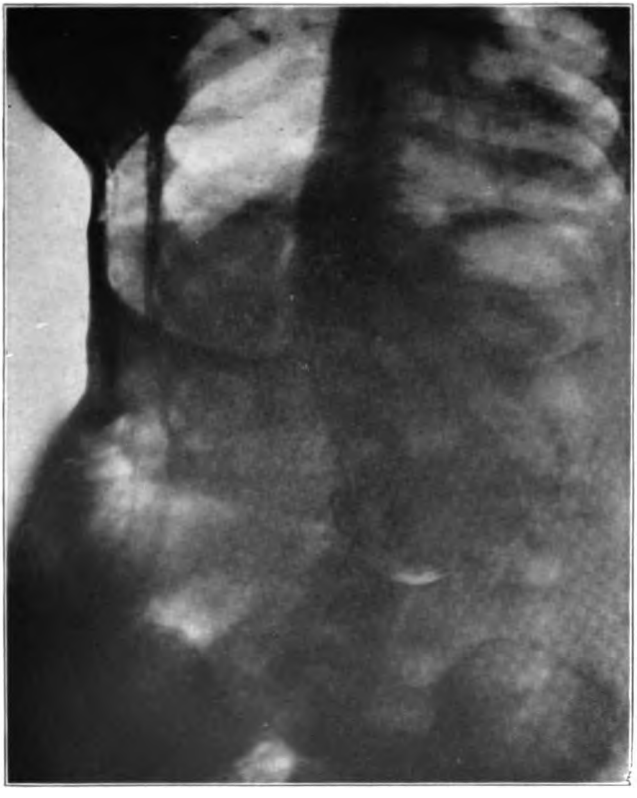

Fig. 5 (Case 4).—June 24, 1916; sixth jacket.

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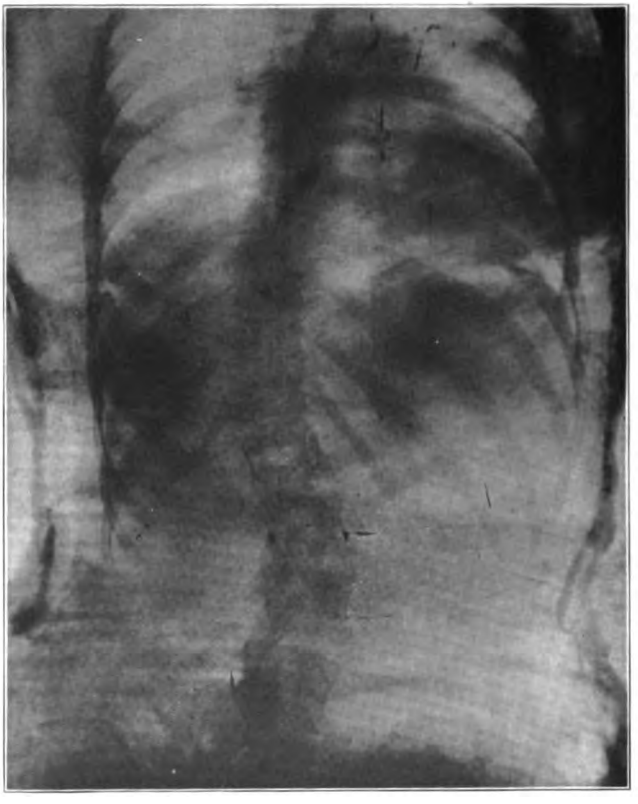

Fig. 6 (Case 4).—Condition of spine, April 16, 1917.

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ABSTRACT OF DISCUSSION

Dr. Albert H. Freiberg, Cincinnati: Many years ago I was associated as assistant with the late Dr. J. Wolff in Berlin, at the time when discussion of the law of the transformation of bones was going on. It had been the theory of many before this time, twenty-five years ago, that cases of adolescent scoliosis, particularly, were produced by some softening disease of bone, which they used also to explain other deformities such as flatfoot and coxa vara, which they considered akin to rickets. So they spoke of adolescent rickets. Wolff came back at them with the argument that they were unable to produce any tangible evidence of its existence, and they were not able to do so. It is not fair to assume that there is no such distinction as that between attitudinal or postural and structural scoliosis. To any one who has examined persons in the third or fourth decade of life who have had a short leg uncorrected, with a curve of the spine, disappearing entirely when in the recumbent position, showing the absence of any structural change, and especially to any one who has made roentgenograms of such patients, as I have done, and demonstrated that no structural changes had occurred, it seems to be impossible that we should hold longer the belief that no such distinction should be made. That the one condition may pass into the other must, I think, be assumed for the present, but that they are distinct conditions must also, I believe, be assumed. Of course the old views regarding adolescent rickets were expressed when we knew nothing of endocrine physiology. We know little enough about it now to be willing to say that it is possible to tell in any case whether it is the thyroid, the suprarenal or the thymus, or simply a disturbance of the endocrine balance, which is responsible for such changes in the bones, which we assume, after a study of physiologic experiments, to result sometimes, at least, from a disturbance of the endocrine balance. I have had the experience, as many others have, of being surprised at a very marked difference in the response to treatment in physically similar cases of structural scoliosis. I have been unable to tell by the severity of the physical changes the degree in which the patient would respond to corrective attempts on my part. I have found sometimes that comparatively slight deformities yield practically not at all, while at other times, rather severe deformity yields easily. It has been my assumption for some time, with a more or less theoretical basis, I will acknowledge, that the differences in these cases were to be explained by differences in that individual, as compared with others of similarly severe deformity, in the resistance of the tissues—perhaps not in the bone alone. I have for some time felt that in certain individuals there is probably a great disturbance of the whole endocrine balance that is to be considered

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in connection with the disturbance occurring at the time of puberty, and that these things may occur under similar circumstances at later periods in life. I should like to ask whether Dr. Peckham has reason to believe that there is any mechanical advantage in applying jackets with the patient face downward rather than face upward in a flexed position.

Dr. E. H. Arnold, New Haven, Conn.: I can do no better than to draw attention to the classification of deformities in Hoffa's book on orthopedics, which I think is serviceable at present. If he defines deformity as a change of shape in a bone or a joint, I think any or all of these symptom complexes must be scoliosis, if they are changes in direction of two bones. Therefore, there is no such thing as pseudoscoliosis, even in cases that show no change in bone structure. Hoffa classified the deformities into congenital and acquired, and divided both into contractures and weight deformities. Then you simply need to go down his list of contractures, section by section—skin, muscle tissue, nerve tissue, etc.—to find the particular kind. This classification covers a great many cases. I think it will throw light on a statement by Dr. Allen in regard to the possible use of scar tissue in holding a spine of the paralytic type; and it will help Dr. Hibbs and others in establishing the correctability of these cases by fusion, and also assist in the correction of weight deformities. These etiologic factors have always been, to me, the determining factors. If one has the symptom complex one must find the etiologic factor; and that has a great range in variety. We cannot always find out why bone softens. It sometimes softens from defects in the several internal secretions, and the deformities may be immense. Hoffa's table has always helped me to make the etiologic diagnosis. That once established, leads to more intelligent treatment.

I also wish that Dr. Peckham would tell us how to apply these jackets. Dr. Abbott, some years ago, owing to some rather painful experience, changed his mind about the use of the heroic method of treatment. He told me that within one year he had changed from a corset that overcorrected markedly and was kept on for a long time, to one less heroic and more frequently applied, believing that the latter would give better results. I think that Dr. Peckham's is an attempt in that direction.

Dr. Royal Whitman, New York: I think scoliosis should be divided etiologically into many different classes. We all recognize the fact that certain weak individuals are predisposed to scoliosis and other postural deformities, but preliminary softening of the bone can hardly be a general cause. In order to support such a contention one must explain why five or six girls are affected to one boy. Also, why the deformity of scoliosis often increases in later years, long

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after any original softening of the bone has disappeared. Furthermore, all the postural deformities must be included. I am much interested in the paper quite apart from the question of etiology and should like to hear more of the details of the application of the jacket.

Dr. Virgil P. Gibney, New York: I should like to have Dr. Peckham say in closing what real evidence he has that the bones are softened.

Dr. Samuel Kleinberg, New York: The severity of the deformity affords no basis of judgment as to the outcome of treatment. We often see cases of mild rotation deformities that resist treatment for a long time and more stubbornly than the severe types. It seems to me that the long total curves are more amenable to treatment than the double curves, particularly the S-shaped curve to which I called attention some time ago. A curve with the dorsal deformity equal to the lumbar is difficult to correct by any known method. The types that have resisted all manner of treatment are the razorback deformity and those with congenital lesions. I have had twenty or twenty-five with congenital malformations of one or more vertebrae, and it is difficult to make any impression on them, even when the curve is very mild. When one has a malformation of the lumbar, or possibly the dorsal, vetebrae, it is impossible to make a serious impression on it. With the milder forms that have not existed a long time we not only can make an impression on the deformity, but correct it in great part by more than one method; not only by the Abbott method, but also by others; for instance, treatment in the erect posture. I have had some patients whom I have treated with jackets in the erect posture, in whom the deformity has become reduced and the patient improved as much as by the more severe method suggested by Dr. Abbott.

I should like to call attention to one type that has interested me, namely, the paralytic back. Paralytic scoliosis is often of a severe type. Can we gain a great deal by placing these patients on their back for a long time? I have recently had two patients who have improved a great deal. Both have been on their backs for six months, using corrective jackets, with a greal deal of attention to the proper application of pressure over the deformity and allowing for expansion of the other side. I think it is a mistake to allow these patients to walk about.

Dr. James W. Sever, Boston: As a matter of fact, in the normal mechanics of the spine, as shown by the experiments carried out by Dr. Lovett, the dorsal spine in the flexed position increases very little in total length; but he has also shown that rotation is freest in the dorsal region when in the erect position and less in the flexed. The more the person is flexed forward, the more the spine is locked against

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rotation; and what is gained in the total length of the spine is very little. So I imagine that mechanically this position is largely an empirical one.

Dr. Frank E. Peckham, Providence, R. I.: The frame that I employ is the gas pipe frame, with cross strips of canvas placed between the sides and canvas going from one end of the frame to the other, so that the curve is kept tight. When the rotary pulls come it is easy to encircle the patient with plaster.

It appears to me as I perform my experiments that when the patient is laid down on a curved surface with the spine upward there is some lengthening and untwisting, simply from position; and if to that is added a rotary pull, more is accomplished. I hope this answers the question about the way of putting on the jacket.

It is rarely that bone softening is not found. We cannot, of course, cut these patients up in order to see how soft the bones are. I was interested to see a patient whose case I have reported straighten up on the administration of thyroid extract. There must have been something to cause restoration of form. Nature tries to grow a thing straight when it has a chance, and with restoration of normal physiology that was what took place. I had an interesting case in a little girl with a slight curve that absolutely resisted treatment. I could push it straight, but it would not stay. I gave her thyroid and she braced up immensely. Then she suddenly went to pieces physically and it was discovered that she had old roots in her gums. They were removed and she has braced up and done well since. Her spine is about straight, and is, I believe, on the road to permanent recovery. That was a mild case, but it was extremely resistant.

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A PRACTICAL EXPOSITION OF OPERATIVE ORTHOPEDICS

ROYAL WHITMAN, M.D.
NEW YORK

The operations of orthopedics are primarily concerned with the disabilities of the locomotive apparatus from the functional standpoint and are often palliative rather than curative in design. Success is dependent, therefore, on qualifications that are not as essential in general surgery. These are a practical conception of human mechanics, and of what may be termed the natural history of the diseases that disable the mechanism.

Operative orthopedics is in the developmental stage. Many operations have been recommended in the past that are defective in design, of which the immediate effects have been mistaken for lasting results. On the other hand, legitimate operations often fail, either because they are not adapted to the age or environment of the patient, or because after-care has been neglected.

This paper is intended as a contribution to what may be termed standardization of operative procedures. It is a report of the routine operations at the Hospital for Ruptured and Crippled under the writer's direction for a period of one year, made up of three consecutive services of four months each, and it may be accepted as fairly representative, except as regards males over 14 years of age, for which there is, at present, no provision.

The number of operations was 1,258. Of these, 375 were forcible corrections, so-called bloodless surgery,

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while the remainder ascended the scale from tenotomies and osteotomies to operations of the major class.

The time at my disposal does not permit a detailed analysis of the material, and I shall, therefore, present only the more important groups as representing conclusions based on a larger experience.

The most important group, numerically, comprises nearly 500 operations for paralytic deformities, chiefly of the foot, including astragalectomies, tendon transplantations and various minor procedures.

ASTRAGALECTOMY AND BACKWARD DISPLACEMENT OF THE FOOT

There were 163 operations for the removal of the astragalus and backward displacement of the foot, all but three of these being for paralytic disability. This operation was originally designed for deformity of the calcaneus type, the aim being to restore the resistance of the foot by displacing it backward so that the scaphoid, being brought into direct contact with the tibia, might check dorsal flexion. As the most common form of calcaneus is combined with valgus, the peronei were transplanted to the Achilles tendon to restore in some degree the power of plantar flexion.

The procedure, varying somewhat in adaptation to the character of the paralysis, is now generally termed the Whitman operation. It was first described in 1901, and is now, I think, established as the only effective remedy for a confirmed calcaneus.

The removal of the astragalus reduces the cavus, the backward displacement restores the prominence of the heel, thus assuring symmetry without violence. The stability thus attained enables the patient to dispense with mechanical support, and the nutrition of the limb improves with the increase in functional ability.

During recent years the field has been greatly extended, and of the 163 operations, but twenty-three were for typical calcaneus. This expansion is

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explained by the fact that the operation assures stability by a change in the mechanics of the joint. Disability and deformity are the effects of uncontrolled movement. Of this the astragalus is the center, permitting in the ankle joint dorsal and plantar flexion, and in the subastragaloid articulations abduction and adduction. By removal of the astragalus and backward displacement, the malleoli are implanted directly on the structure of the foot, near its center, thus reducing adverse leverage and changing a complicated joint to a very simple one, permitting movement only where it is of functional value.

The operation is often indicated in cases of marked valgus, particularly when associated with cavus. Even in cases of complete paralysis, the so-called dangle foot, it often assures sufficient stability to enable the patient to dispense with support, while the restoration of the resistance of the forefoot by this means makes hamstring transplantation effective in cases of paralysis of the anterior thigh group. Although the chief object of the operation is to supplant mechanical support, it is of service in cases of complete paralysis of the limbs, to lessen the burden and discomfort of braces by simplifying their function.

As has been stated, the operation is often combined with other procedures, the transplantation of the peronei for calcaneus, occasionally transplantation of the tibialis anticus or posticus, or with the implantation of the paralyzed peronei in the fibula, in cases of varus, although the backward displacement of the foot makes this latter operation of little mechanical value.

The operation has the great advantage of dependability, even under the adverse conditions of hospital practice. To assure satisfactory results, however, it is essential that it be performed according to the author's method,[1] recently described in THE JOURNAL by McAusland.[2]

1. Whitman, Royal: Med. Rec., New York, Jan. 10, 1914.
2. MacAusland, W. R.: Astragalectomy (Whitman Operation) in Infantile Paralysis, THE JOURNAL A. M. A., Jan. 27, 1917, p. 239.

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MUSCLE OR TENDON TRANSPLANTATION: 129 OPERATIONS

The most important example of muscle transplantation as distinct from tendon transplantation is of the hamstrings for paralysis of the quadriceps extensor. There were thirty-nine of these operations, twenty-four of the biceps and fifteen of the inner group. The object is to restore stability in walking, and this may be assured usually by transplantation of a strong biceps, if the calf muscle is active, or if the resistance of the foot has been restored, by astragalectomy and backward displacement.

The method differs in some details from that usually employed. The biceps muscle is exposed by a long incision and its attachment is separated from the head of the fibula, together with a portion of the underlying cartilage or bone. The short head is dissected from the femur, as far as the middle of the shaft, the aim being to assure a straight pull from the tuberosity to the patella. An incision is made over the patella, through the quadriceps tendon and the capsule into the joint, but if possible avoiding the synovial membrane. A second opening is made in the lateral wall of the capsule, a free channel having been opened between the fascia and the skin, the biceps tendon is drawn through the lateral opening in the capsule, out through the split quadriceps tendon, and the cartilaginous end is embedded beneath the separated periosteum on the surface of the patella. It is firmly attached at these three points by kangaroo tendon. The limb is fixed in extension by a plaster spica until repair is complete. A brace is then applied to assure for several months the extended attitude, after which it is discarded.

In the most successful cases the power of extending the leg against the force of gravity is restored, and in all the control of the limb in walking is satisfactory if the transplanted muscle is of normal strength.

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If the biceps is incompetent, the inner hamstrings, the semimembranosus the stronger, and the semitendinosus, the weaker are transplanted. The method is the same, but the result, though usually satisfactory, is less so than after transplantation of the biceps, because of the mechanical conditions, the muscular pull being less direct.

It is very important that any limtiation of extension at the knee be overcome, in order that the bones may, as it were, lock when weight is borne, and that the resistance of the forefoot to dorsal flexion, if impaired, be restored; slight equinus, which has a tendency to push the knee backward, being the most favorable attitude. It may be noted that silk extensions are never used and are not required because the muscles, being separated at their insertions, are long enough.

One other independent operation is transplantation of the trapezius for paralysis of the shoulder. If the trapezius is strong, its transplantation assures security at the joint, aids function and lessens the tendency to elevation of the shoulder.

Tendon transplantation is especially indicated for paralytic disabilities of the foot. It should not be performed until deformity has been thoroughly corrected. In its original form it is unreliable, and it is usually supplemented by other procedures to assure stability, such as tendon implantation and arthrodesis.

Talipes equinovalgus, the most common of the minor deformities, is usually caused by paralysis of the tibialis anticus alone, or in combination with the posticus. The ordinary operation consists of the implantation of the tibialis anticus tendon into the tibia, and the transplantation of the longus hallicus to the inner border of the foot. If the valgus is well marked the peroneus brevis is also transplanted to the same locality, or if the tibialis posticus is paralyzed, behind the inner malleolus. The function of the peroneus longus is so important that it is not usually disturbed. If the

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patient is an adolescent, an arthodesis of the astragalo-scaphoid articulation is performed to aid stability, and less often of the posterior articulation between the astragalus and the os calcis.

It must be borne in mind that all the dorsal muscles except the tibialis anticus are abductors, and that in cases of long standing the extensors of the toes are displaced outward and fixed in this position by a shortened peroneus tertius. When this muscle has been separated from its attachment the sheaf of tendons may be drawn to the inner side and fixed there by looping the tibialis anticus tendon about them and then implanting it in the tibia, so that they may serve to adduct rather than abduct the foot.

Varus is usually treated by the transplantation of the tibialis anticus to the outer border of the foot, by implantation of the paralyzed peronei tendons in the fibula, and in selected cases looping them about the toe tendons in the manner described. If the tibialis posticus is active, it is sometimes transplanted to the Achilles tendon. Arthodesis of the subastragaloid articulation, and in advanced cases the removal of a wedge from the outer border of the foot, are supplementary procedures.

In some instances the tibialis posticus and the peroneus tertius have been displaced forward of the malleoli and attached to the toe tendons to serve as dorsal flexors in cases of drop-foot.

After tendon transplantation the foot is fixed for a long time in the overcorrected position, walking being permitted when it causes no discomfort, in order that both attitude and functional use may be opposed to the recurrence of the deformity. The protection of the foot by a well-balanced shoe, exercises of the transplanted muscles, systematic stretching of tissues that tend to contract, and mechanical protection when indicated, are essential. For, as has been stated, tendon transplantation is unreliable and success in great degree is dependent on the after-treatment.

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TENDON IMPLANTATION: FORTY-SEVEN OPERATIONS

This operation, as revived and improved by Gallie, has, I think, in great degree supplanted the use of silk ligaments. It is most useful in conjunction with tendon transplantation, as an aid in restraining deformity, and is rarely performed independently.

The most common operations are the implantation of the tibialis anticus tendon in the tibia for valgus, and of the peronei in the fibula for varus. I have never attempted to implant a portion of the Achilles tendon in the tibia in connection with the transplantation of the peronei to restrain calcaneus, because it seems to me from the mechanical standpoint that the removal of the abductors must eventually induce to varus deformity.

ARTHRODESIS

Arthrodesis is no longer performed for the purpose of fixing the foot at a right angle with the leg by inducing ankylosis at the ankle and other joints. It is too radical unless the paralysis is extensive, and it is not usually effective at the age at which the majority of operations for paralytic deformities are indicated. The character of the ankylosis is such that there is often discomfort after strain. Finally, right angular fixation is undesirable, since it prevents the use of an inoffensive shoe in compensation for the shortened limb, which is almost always present in cases of extensive paralysis.

Arthrodesis, to check lateral motion by fixing the astragaloscaphoid or subastragaloid joints, is not open to the same objection. It is a useful adjunct to tendon transplantation, and bone pegging, as suggested by Soule, may make it effective at an early age.

SILK LIGAMENTS

There were no operations for the insertion of silk ligaments, and I think the operation is falling into disuse, partly because it has been supplanted by tendon implantation, but chiefly because experience has

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shown that transformation of silk strands into fibrous tissue sufficiently resistant to restrain deformity without mechanical support is very doubtful.

Personally, I have practically discarded silk even for the attachment of transplanted tendons, because it seems to me that security is dependent on a vital union of tissues for which the suture only assures the opportunity.

CLUB FOOT: SIXTY-FIVE CASES

The cases of congenital clubfoot seen in the hospital are usually in later childhood and are of the type representing ineffective treatment.

In suitable cases the deformity is immediately corrected by forcible manipulation, combined with subcutaneous division of the resistant tissues, followed by fixation in the overcorrected attitude until the new position has been thoroughly impressed on the tissues.

In the more confirmed types correction is made, if possible, by the division of the soft parts, rather than by the removal of bone. The chief resistance is in the ligaments on the anterolateral and posterior aspects of the ankle. These are thoroughly divided through a long internal incision somewhat after the method of Ober, which has practically supplanted the Phelps operation.

If the neck of the astragalus is twisted inward, it is divided, and if the body of the astragalus cannot be replaced, the malleoli are separated sufficiently to permit reduction, combined with minor osteotomy if necessary. It would appear that the limitation of dorsal flexion so often observed, even in what are classed as good results, is due to the incomplete replacement of the astragalus, apparent correction having been obtained by twisting the forefoot outward and upward at the mediotarsal joint.

The reduction of deformity by the primary removal of wedges of bone from the outer border of the foot is not favored in childhood, radical operations of this

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type being reserved for more extreme deformity in older subjects, as in two adult cases in which the removal of the astragalus combined with cuneiform osteotomy was required to restore symmetry.

CONGENITAL DISLOCATION OF THE HIP: FIFTY-TWO OPERATIONS, SIXTEEN BY THE OPEN METHOD

Operations for the reduction of dislocations of the ordinary type by the Lorenz method, or its modifications, are usually performed in outdoor clinics. The patients admitted to the hospital are of a less favorable class, and often after failure of treatment.

In many cases the cause of the failure is an anterior twist of the neck of the femur, combined in most instances with a shallow acetabulum. The most important cases of this class are those of bilateral dislocation, in which the cure on one side seems to have increased the disability by replacing the waddle by a limp. The operation is usually of the Hoffa type. The acetabulum is enlarged and deepened with the aim of assuring security in spite of the distortion of the neck. In fact, the anteversion which prevents accurate adjustment prevents also ankylosis, and assures a sufficient range of motion. Osteotomy for the correction of the twist as a preliminary to manipulative reduction is not likely to be successful, at least in the anatomic sense, because of the shallow acetabulum.

OPERATIONS FOR TUBERCULOSIS

Operations for tuberculous disease have steadily decreased in recent years, both in relative and absolute importance.

There were sixteen operations on the spine for Pott's disease, fifteen by the Albee method and one by that of Hibbs, the former being preferred because of its simplicity and because it assures more immediate support. Operative treatment is most satisfactory in the adolescent or adult class. For younger patients it is considered simply as a valuable adjunct to conservative treatment in selected cases, but in no sense curative.

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Bone transplantation was also performed in a case of spondylolisthesis with good result.

There were three resections—one at the hip and three at the knee, and one amputation at the hip; also nineteen osteotomies of the Gant type, and many forcible corrections of deformity resulting from disease at various joints.

OPERATIONS ON BONES AND JOINTS

There were twenty operations for fractures, either for nonunion or malunion, four at the hip joint. Also two operations at the hip for inducing ankylosis for arthritis deformans, and three for the correction of coxa vara.

There were nine arthroplastics: five at the hip, two at the elbow, one at the knee and one of the jaw, the free flap, of fat and fascia, being employed.

Of the minor operations there were 163 osteotomies: 148 for bowleg or knockknee, as contrasted with twenty-three fractures by the osteoclast, showing a decided preference for the former procedure.

OTHER OPERATIONS

Of the less common operations, there were nine for torticollis, all for long-standing deformity. The contracted tissues were completely divided through an incision just above the clavicle. The deformity was then overcorrected and the head fixed for several weeks in a plaster support. Later, systematic stretching and exercises completed the treatment. No apparatus was used.

There were also four operations for ischemic paralysis and contraction of an extreme type, in three of which mechanical correction by the Jones method was supplemented by lengthening of the more resistant tissues by an open incision.

As has been stated, the purpose of this review is to illustrated the types of orthopedic operations and the relative importance of this branch of surgery. It may

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be again emphasized that in many instances the operation was simply incidental to a systematic course of treatment continued in the outdoor department after the patient was discharged from the hospital, and that on such opportunity for supervision and after-care success is in great degree dependent.

ABSTRACT OF DISCUSSION

Dr. Samuel Kleinberg, New York: It must be borne in mind that the primary objects of any operation on a paralytic limb are: (1) to establish power and function in a direction in which these were destroyed through the paralysis; (2) to afford stability to the paralyzed limb; (3) to enable the patient to discard his apparatus, or at least to use it with less difficulty. An operation to be of value must obtain permanently one or more of these results. Many operations have been devised. Osteotomies, tendon transplantations and implantations, astragalectomy, arthrodesis, etc. Each operation has a special purpose and therefore special applicability. There are, however, so many different types of deformity and so many different combinations of paralyzed muscles that it is difficult to arrive at absolutely definite and standard indications for, and thus circumscribe the usefulness of, every operation. Rather should we remember the value of each procedure and in studying our cases apply to each patient one or more of the different operations which seem best adapted to accomplish the desired object. Thus one can frequently and with advantage combine arthrodesis or astragalectomy with tendon transplantation or tendon implantation.

I would emphasize the necessity for thoroughly correcting a deformity before applying any operative measure. This preparation of the paralyzed member enhances the value of the operation and helps to prevent recurrence of deformity. Moreover, one often finds that when a persistent attitude is overcome, muscles apparently inactive begin to functionate. Frequently used operations are the following:

Astragalectomy: The primary object of this operation is to give stability to the ankle. To obtain this it is essential that the operation be performed with due regard to every detail, but especially to the thorough backward displacement of the foot. Care must be taken that the foot is put up in valgus. To assure this attitude Dr. Whitman suggested about two years ago that we sew the tissues directly over the cuboid to the periosteum of the fibula. This suture minimizes the tendency of the foot to slip about and assists in retaining the foot in proper position while the plaster is being applied. Astragalectomy was originally devised for calcaneovalgus. Inasmuch, however, as its chief result is stability of the ankle,

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the operation can frequently be used with advantage in dangle feet and in cases with very extensive paralysis about the ankle.

In tendon transplantations and implantations three factors are essential for success: (1) overcorrection of the deformity; (2) securing fixation of the transplanted or implanted tendon; (3) prolonged retention in the overcorrected position.

The results from these operations as observed at the Hospital for Ruptured and Crippled and in my private practice are, in most instance, favorable. The chief benefit appears in maintenance of the limb in a better attitude and control of the deformity. The tendon operations must, of course, be sppplemented by persistent and long-continued after-care, by especially constructed shoes, carefully planned exercises, etc. The most favorable results from tendon transplantation are found about the knee. Recently I studied a series of eighteen patients in whom the inner or outer hamstrings were transplanted for paralysis of the quadriceps. Thirteen were biceps transplantations, and in all of these cases there was a gain of voluntary extension of the knee varying from 10 degrees, to full and forcible extension. Of the other five cases, all transplantations of the inner hamstrings, in one there was a gain of 45 degrees of voluntary extension; in the others there was no voluntary extension. In these latter as well as in the biceps cases the limbs were decidedly more stable, the patients were able to discard their apparatus and had acquired a sense of security that greatly helped them in walking. The biceps femoris is the most favorable muscle for transplantation, as its employment practically always results in the reestablishment of some degree of voluntary extension.

Transplantation of the trapezius for deltoid paralysis has been very disappointing to me, as I have not seen any case in which there was any gain in active abduction of the arm. The most that, apparently, we can expect from this operation is that the shoulder may become a little less relaxed than it was before the operation. This improvement, however, is often so slight as to be of no practical advantage.

Dr. Edwin W. Ryerson, Chicago: Dr. Whitman's effort tc standardize certain types of deformities is wise, and we should learn, if possible, what is the best thing to do for certain of the more common deformities. I feel that it is unfortunate to name an operation after the originator of it, that is, after any man's name; yet one cannot describe Dr. Whitman's operation of astragalectomy, etc., in the single word astragalectomy. Formerly, I thought that was possible, and did many operations which I believed were Whitman operations. but which were not and the results were not good. Simple astragalectomy is practically useless in these cases. The operation must be done according to Dr. Whitman's technic, and it then becomes the most useful single operation that I

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know of in the surgery of infantile paralysis. The surgery that we do in most of these cases is primarily for the purpose of increasing stability in the use of the legs; secondarily, to render it unnecessary to employ braces. We do not wish to condemn these sufferers to lifelong brace treatment if it is possible to avoid it by means of a comparatively safe, simple and efficacious operation. Some of the work is still in the experimental stage, but the treatment of appendicitis and ovarian cysts was once in the experimental stage and the work had to be standardized.

Speaking of transplantation of the hamstring tendons, the next most useful operation, I think, is to transplant one muscle from each side of the popliteal space—the biceps femoris from one side and the semitendinosus from the other —as this makes a more symmetrical arrangement of them. I have performed the operation many times and do not find it necessary to take a piece of the head of the fibula in transplanting the biceps. If we cut it low down and weave in a kangaroo tendon anchor suture we can sew it firmly into a groove cut in the patella longitudinally, and can further fasten it with interrupted catgut sutures. This method is very reliable. In using the semitendinosus we can preserve its sheath, which will prevent any possible adhesion to the skin.

Going back to the biceps transplantation, it is not necessary to use the short head of the biceps, which is made up of short muscle fibers arising from the shaft of the femur. It is much better to prolong the incision up toward the ischium and dissect up the long head of the biceps with the thumb and forefinger and rip it down towards the insertion. The long portion of the biceps can be separated completely from the short head, which is more of a hindrance than a help, and the implantation can be made in the usual way.

The operation of Gallie of implantation of tendons into the bones to form ligaments is useful and prevents or relieves varus and valgus. It has been in most cases a failure in my clinics, however, in relieving equinus. The implantation of the tibialis anticus tendon does not suffice to hold the foot up against the force of gravity. Gallie himself told me that he was not satisfied with the results in some of these cases. We must seek some other method. I have discarded silk ligaments, not because they did not form an efficient support, but because in a few cases the silk subsequently acted as a foreign body; and though the cases formed a small number of the total percentage, we should not advocate a method unless it can be universally successful. If the piece of silk ever acts as a foreign body and has to be removed in any cases treated under aseptic technic, we should not, in my opinion, seek to standardize the operation.

Dr. Melvin S. Henderson, Rochester, Minn.: As Dr. Ryerson says, this is an attempt at standardization of operative

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procedures. The question that I want to ask bears on the matter of anesthesia, and is not directly connected with operative technic. Last year in the Mayo Clinic we undertook a study to determine the frequency of pneumonia following anesthesia. We found that it occurred more in abdominal operations than in any other type, and that the nearer the operative field was to the diaphragm the greater the liability to pneumonia. The cases occurred under local anesthesia as frequently as under ether. The interesting point of the study was that in 1,000 orthopedic operations there was no case of postoperative pneumonia. I should like to ask Dr. Whitman whether he has had postoperative pneumonia in orthopedic cases.

Dr. Henry Keller, New York: One remark that Dr. Whitman made ought, I believe, to be more elaborated, because it may be misunderstood. It is in regard to the Albee operation on the spine for the cure of Pott's disease. Dr. Whitman said that the operation should be done on adolescents and adults, and that in children it should be considered as an adjunct to the treatment only, and not as a curative procedure. Now, I am certain that Dr. Whitman concurs with the opinion of most observers that the Albee operation, per se, does not cure tuberculosis of the spine, no matter at what period of life the patient has been operated on—adolescent, adult, or in childhood. The operation supplies the diseased spinal column with a natural splint, and in virtue of its immobilizing property may hasten the cure. The operation, however, in order to render lasting results, must be followed by a mechanical support of the spinal column for a shorter or longer period, depending on the progress of the case. The only difference, therefore, between the child and the adult is that, whereas time is an important sociologic and economic factor in diseases affecting adults, any procedure which can hasten the curative period should be employed as early in the disease as possible, while in children, time playing no important part, conservative treatment should be instituted for six or eight months and if no improvement follows the ankylosing operation of the diseased vertebrae should then be undertaken. Dr. Whitman in closing the discussion, will, I am sure, make that point clear.

Dr. Royal Whitman, New York: There was no case of pneumonia following the operations.

Dr. Albert H. Freiberg, Cincinnati: Do you know what mortality there was?

Dr. Whitman: There was no mortality due to operation. I have had in my experience but three deaths. One was after correction of deformity in a case of spastic paralysis. One was in a recent case of poliomyelitis in an adolescent, with great contractions, in which the limbs were straightened

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by open incision. The third was in a young child from nitrous oxid anesthesia.

In reply to Dr. Keller, as to the Albee operation as simply an incident in treatment: I made this statement because Dr. Albee formerly, at least, claimed that the operation was curative and advised the removal of apparatus in order that the graft might hypertrophy under the increased strain. Personally, I do not consider the operation curative in any class of cases; but I think that it is more efficacious in the treatment of adolescents and adults than in children.

With regard to the operation for drop foot, since the limb is often shorter than its fellow, it is not necessary to fix the foot at a right angle, but rather to assure security and to adjust the shoe to a degree of plantar flexion that will equalize the length of the limbs.

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OPERATIVE TREATMENT OF TUBERCULOSIS OF THE KNEE JOINT IN ADULTS *

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AND

EDWARD C. BULL, M.D.

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Tuberculosis of the knee joint in adults differs in two important points from the same disease in children.

1. In children we have centers of growth in direct anatomic relation to the joint. Disturbance of these centers by the disease or by operative interference may seriously affect the ultimate length of the limb. This condition requires consideration and treatment.

2. In children there seems to be a more marked resistance to the disease than in adults, and cures with only slight disturbances of function often occur when persistent and continuous local fixation is combined with general treatment by heliotherapy and an antituberculous regimen.

In adults, the disease when once established, in our experience, may be said never to recover fully without operative interference of some form.

We realize that this is a sweeping and dogmatic statement, but we have yet to see a tuberculous disease of the knee joint in which the diagnosis has been conclusively established by means of tuberculin tests showing general and local knee joint reaction, by means of examination of tissue removed for purposes

* From the Orthopedic Department of the Massachusetts General Hospital.

* One patient was operated on at the age of 17; the others were 18 to 54 years of age, respectively.

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of microscopic study, or by means of positive guinea-pig inoculation of fluid removed by aspiration, gain a lasting recovery without operative interference.

DIAGNOSIS

We do not believe that the diagnosis of tuberculosis of the knee joint in adults can with certainty be made in the early stages of the disease from clinical examination alone. Several other monarticular affections may well be mistaken for it; a gonorrheal infection of subacute character; a syphilitic infection; a villous arthritis; a simple chronic synovitis of unknown origin, or a chronic traumatic arthritis.

We shall not attempt to indicate the important points in the differential diagnosis, but rather to emphasize the fact that in our opinion it cannot at times be made without the help of the laboratory tests enumerated in the foregoing. It is fair to say that any rather subacute affection of the knee joint, in which the subjective symptoms are often intermittent and which objectively is characterized by a persistent but variable change in the external contour of the joint and an atrophy of varying degree of calf and thigh, should be considered to represent tuberculosis of the knee joint unless there exists proof to the contrary.

We have become convinced that tuberculosis of the knee joint in adults is at times primary in the synovia. Our belief is based on the failure to find evidence of bone involvement by careful Roentgen-ray examination, by macroscopic examination at operation, by subsequent recovery as the result of arthrotomy and the injection of 4 per cent. iodoform and olive oil emulsion, and on the positive evidence of tuberculosis of the synovia by microscopic examination and the positive inoculation tests of guinea-pigs with the removed tissue or joint fluid.

TESTS

We have found the von Pirquet test to be of only negative help in excluding tuberculosis.

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If the patient has no elevation of temperature and is placed on a two-hour chart, and if he reacts to a subcutaneous injection of Koch's old tuberculin by a slight or marked febrile rise and an increase in the local joint symptoms, as indicated by greater sensitiveness, added heat, or both, we believe an almost positive diagnosis of tuberculosis of the knee joint may be made. It is the practice of the clinic with which we are associated to begin with an injection of 0.1 mg. If no reaction occurs in two days, an injection of 1 mg. is given. If still no reaction, two days later an injection of 3 mg. is given, and if there remains no reaction to this and to a last injection of 5 mg., we consider the test to be negative.

We have no statistics as to the percentage of cases later proved positively to be tuberculosis in which this test fails to give any local or general reaction. We know that we sometimes fail to obtain it, but our impression is that the percentage of failures is very small.

ROENTGENOGRAPHIC EXAMINATION

The diagnosis by roentgenogram is often confirmatory, but opinion should in few cases be made conclusively from this evidence when considered alone. Tuberculosis is a destructive process, and when the bone is affected, loss of substance will often be shown; but when the disease is creeping in beneath the articular cartilage, it may not be evident in the roentgenogram. There is occasional lime salt deposit beneath the periosteum. Typically there is a hazy appearance of the articular surfaces.

The Wassermann reaction and the gonococcus complement fixation reaction are done as a routine in this clinic.

OPERATION

It is our belief that an operation should be contemplated as soon as the diagnosis has been made. It is often wise to defer the operation in a case in

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which there has been no fixation and in which the knee is in a more or less acute and irritable state. Such a patient should be put at once at complete rest and freedom from weight-bearing for perhaps a month, and when the acuteness of the disease has subsided, the appropriate operative procedure may be more safely executed, with less postoperative reaction.

Only two types of operation have for many years been considered in the clinic: the one conservative of function and representing little or no shock, attempting to cure the disease by keeping synovial surfaces apart and bathing them in an antiseptic oil; the other destructive of function, a major operation, attempting to cure the disease by destroying the joint and eliminating the synovial membrane and the red bone marrow.

TABLE 1.—CASES OF BONE AND JOINT TUBERCULOSIS TREATED FROM THE OUTPATIENT DEPARTMENT OF THE MASSACHUSETTS GENERAL HOSPITAL FOR TEN YEARS UP TO 1917

	No.
Total cases treated in outpatient department	239,867
Total cases treated in orthopedic department	20,079
Cases of bone and joint tuberculosis	1,336
Cases of tuberculosis of knee treated in outpatient department	206
Cases of tuberculosis of knee treated in orthopedic department	181

When we believe that the tuberculous disease exists only in the synovia, we have been advising our adult patients to submit to an exploratory arthrotomy through a 3 inch lateral incision, and if no bony disease can be found at operation and the macroscopic findings are consistent with tuberculosis, we have been injecting a bland olive oil containing 4 per cent. of iodoform after the method of Brackett.[1] A considerable number of these patients (eight out of thirty) with tuberculosis of the knee have apparently been cured in his hands and able to regain function. For the technic of the operation, the reader is referred to Brackett's carefully written and excellently illustrated paper. Suffice it to say that from 1 to 5 ounces of the 4 per cent. iodoform oil are injected

1. Brackett: Boston Med. and Surg. Jour., June 4, 1914, p. 873.

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after the joint has been opened, the fluid evacuated, and the adhesions and pannus, if it exists, carefully separated. The deeper layers of the capsule and the synovia are closed by a continuous stitch from each end, a small opening being left in the middle for the nozzle of the glass syringe. A special double loop lock stitch is inserted and pulled tight about the nozzle, and the oil injected with considerable tension and the lock loop pulled home. Oil has been recovered from the joint eight weeks after the operation in an apparently unchanged condition.

For the detailed after-treatment, the reader is again referred to Brackett's article. Complete fixation is never employed, though the patient bears weight in a split cast only after several months. The cast is removed every day for gentle passive movements. Sometimes two, and in a few cases three, injections

TABLE 2.—CASES OF BONE AND JOINT TUBERCULOSIS TREATED IN THE MASSACHUSETTS GENERAL HOSPITAL IN THE THREE YEARS PRECEDING 1917

	No.
Total cases treated in hospital	19,423
Cases of bone and joint tuberculosis	321
Cases of tuberculosis of knee treated in hospital	61
Cases of tuberculosis of knee treated in orthopedic ward	55

are given if we can obtain no evidence of the involvement of the bone and the evidence of active synovial disease still exists.

If the evidence presented shows that disease of the bone exists, we have come to believe that excision is the procedure to be unqualifiedly advised. As we have said previously, if the disease is acute there should be an initial period of complete rest and fixation, but we have never seen permanently satisfactory function restored in a knee joint in which tuberculous disease has involved the bone. The disease often becomes quiescent under complete fixation, but subjected to use without protection, these apparently healed joints light up, and the disease advances, though the history may extend over a period of years.

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We do not maintain that there never has existed a permanent cure of tuberculosis of the knee joint which has involved the bone, without an excision or an erasion or some procedure which obliterates the joint, but we do say that we have never seen one, and until we do we shall continue to advise for these cases excision as the method of choice.

TABLE 3.—END-RESULTS IN SIXTY-NINE CASES OF TUBERCULOSIS OF THE KNEE IN ADULTS TREATED BY OIL ARTHROTOMY AND EXCISION; OPERATIONS DONE ON THE ORTHOPEDIC SERVICE OF THE MASSACHUSETTS GENERAL HOSPITAL, 1907-1917

		No.
Cases of oil arthrotomy		17
Cases of excision of the knee		52
Oil arthrotomy results:		
(a) Apparent cures		4
(b) Improved patients		4
(c) Patients not improved (1 died)		6
(d) Patients lost sight of		3
Means of internal fixation in excisions:		
(a) No internal fixation		1
(b) Bone plates, wire clamps or nails		30
(c) Kangaroo tendon		21
Secondary operations required:		
(a) Oil arthrotomy		4
(b) Excision		4
(c) Reexcision		4
(d) Amputation		7
(e) Removal of plates, wire clamps or nails		14
Number of excision cases with firm union		38
(a) In one month or less:		
Bone plates, etc.	6	
Kangaroo tendon	0	
(b) In one to two months:		
Bone plates, etc.	4	
Kangaroo tendon	2	
(c) Three months or more:		
Bone plates, etc.	17	
Kangaroo tendon	9	
		Months
Average time required for bony union in last 24 cases		9.2
(a) In cases with bone plates, nails, etc.		9.5
(b) In cases with kangaroo tendon		8.25
No record of eventual union (including amputations):		
		No.
(a) Bone plates, nails, etc.		4
(b) Kangaroo tendon		10
Mortality		1
		14
Failure to avert disease:		
(a) Oil arthrotomy (1 patient died)		6
(b) Excision		14
Failure to secure good functional result:		
(a) Oil arthrotomy		10
(b) Excision		14
Successful results as to cure of disease and usefulness of limb:		
(a) Oil arthrotomy		4
(b) Excision		36

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Technic.—In discussing the technic of the operation for excision of the knee we shall describe that which after a period of years has seemed to us the more useful. The most careful two day or three day preparation of the skin is given. A tourniquet or an Esmarch is applied.

Incision.—A wide U-shaped incision is plotted by making three or four small skin scratches which will run at right angles to the U-shaped skin incision. Through these the main incision is made, and by matching the skin scratches, eventual nice apposition of the skin is made easy. The incision is carried down to the bone, from condyle to condyle, through the patellar tendon. The patella and flap are pulled upward, the crucial ligaments cut as the knee is flexed, and the whole joint cavity exposed. A quick, moderately complete dissection of the tuberculous tissue is carried out, and the patella, if badly diseased, is removed. If only its cartilage is affected, the articular surface is removed with a saw, and it is used later as a bone graft.

The really important judgment of the operation must be exercised in determining the amount of bone to be removed and the plane of the cuts. If paper patterns of the bones as shown in the lateral roentgenograms are cut before the operation and the amount of flexion to be desired because of the social conditions of the individual patient be determined, these patterns can be made to indicate in a fairly accurate way the planes of the saw cuts.

The determination of how much permanent flexion it is advisable to obtain for the patient is an important question. It is more than is generally thought to be wise. Brackett especially has called attention to the usefulness of even 45 degrees of permanent flexion in a man with a largely sedentary occupation. With a high sole and heel, walking is not as awkward as would be expected, and is more than offset by ease in sitting.

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Our opinion is that in a man or woman with a sedentary occupation, from 35 to 40 degrees of flexion is the position of choice. If the work is to be chiefly ambulatory, from 15 to 20 degrees seems to offer the best functional position.

The bone is removed best with a miter saw, and after the slices have been taken from both femur and tibia, and perfect apposition in the desired position has been obtained, the posterior disease is removed down to the capsule.

We have become convinced that some method of internal fixation of the bone ends is greatly to be desired. Union is certainly quicker, postoperative pain is less, and early union favors early cure. Reference is here made to a study of the end-results of excision of the knee made by one of us.[2]

The method of internal fixation by means of bone plates and screws or by the Goddu aluminum wire clamp is satisfactory in many cases. The fact that in a considerable number of cases these plates or clamps had to be subsequently removed did not seem to delay speedy and satisfactory cure of the disease or early firm union. Two flat vanadium or plain steel plates have been most commonly used, placed laterally on the inner and outer sides. These plates may be quite accurately shaped before operation by cutting out a paper pattern of the anteroposterior roentgenogram, performing a paper excision, and fitting the plates to the lateral outlines. There are many cases, however, in which the atrophy of the bones is so considerable that even coarse-threaded wood screws get no grip and the plates offer little if any fixation. In such cases and in certain others (in order to try the method) we have been employing a suture of kangaroo tendon, which we believe to be useful. It may be called a "bundle knot tie," and is made with double kangaroo tendon for double strength, less likelihood of cutting,

2. Osgood, R. B.: Boston Med. and Surg. Jour., July 24, 1913, p. 123.

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and greater length of tie. With a hand drill, in the end of which is a large eye, while the knee is flexed, a hole is bored straight through the femur from front to back, about 1.5 cm. above the cut surface. It may be necessary with a periosteum elevator to free the posterior capsule upward on the femur and downward on the tibia. With the knee flexed there is no danger of wounding the vessels if the drilling is carefully done. Through the eye of the projecting drill the two ends of a stout kangaroo tendon suture are threaded and pulled back. A second suture is now looped to the first and its two ends pulled through a symmetrical drill hole in the tibia. Next, a hole is drilled through the femur from side to side about 2 cm. above its cut surface, and a double kangaroo suture drawn through. Its looped end is looped to a fourth suture, which in turn is drawn through a corresponding hole in the upper end of the tibia. When the knee is extended and the apposition is accurate, the knots are tied tight and give a surprising amount of fixation. If only the joint surface of the patella has been removed, a bare bone bed is prepared for it and the sutures tied through and over it.

Smith-Peterson has suggested that the external and internal portions of the posterior capsule be tightly fastened together with kangaroo tendon when the knee is flexed. This is a reinforcing suture, and when the knee is extended, tends to keep the posterior bone surfaces from separating and to prevent the gap so often seen in the early subsequent roentgenogram as gravity tends to extend the leg. When all the sutures are tied, the skin and fat flap is closed with chromic gut in layers without drainage, and the skin with interrupted silk or silkworm-gut. The tourniquet is usually not removed until this has been done, and we do not as a rule find it necessary to tie any vessels. As soon as the bone ends are fixed by the plates or the sutures, an assistant devotes his entire attention to holding the

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limb in a position in which the close apposition will be maintained; and as soon as the dressing is in place a sterilized sheet iron or steel ham splint, bent previously to the determined angle, is placed beneath the limb, and with the assistant still holding, a plaster is applied from toes to groin. We hope for fairly firm callus in four weeks, we expect it in eight, and we are disappointed if the patient cannot bear some weight with artificial support in three months.

The importance of function in converting fibrous union into bony should be emphasized, cases having occurred with fibrous union for many months which rather rapidly became rigid on beginning moderate function with plaster support.

The general health of the patient often greatly improves when this focus of disease is removed. The operation is not necessarily contraindicated in the presence of visceral disease elsewhere, and we have seen such lesions improve after an excision.

With the kangaroo bundle suture, even discharging sinus cases, if not too badly secondarily infected, may be induced to become solidly united and to overcome their disease.

The occurrence and results of the cases of tuberculosis of the knee joint in adults occurring in the orthopedic clinic of the Massachusetts General Hospital since 1907 are submitted in the accompanying tables.

CONCLUSIONS

1. Tuberculosis of the knee in adults is not fully cured without operative treatment.

2. Primary synovial tuberculosis of the knee in adults exists and is frequently improved or cured by inflation of the joint with iodoform oil.

3. We have seen no permanently satisfactory function restored in cases with bone involvement.

4. Excision of the knee is the method of choice in cases with bone involvement.

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5. The position of choice is from 15 to 20 degrees' flexion for ambulatory vocations, and from 35 to 40 degrees' flexion for sedentary occupations.

6. Bone plates, where the bone is firm, and the kangaroo tendon "bundle tie," for conditions in which there is much atrophy, are valuable means of internal fixation.

7. Function is important for final bony union after excision.

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ABSTRACT OF DISCUSSION

Dr. Melvin S. Henderson, Rochester, Minn.: The operation of resection of the knee joint has been used in the Mayo Clinic for years, and we consider it one of the most satisfactory operations that we have.

The statement was made in the paper that the authors have never seen a case of knee-joint tuberculosis in an adult get well without operation. I can record two such cases in which the patients got well without radical operation. The cases were synovial in type, clearly proved to be tuberculous by guinea-pig inoculation. Both patients have now been well for over three years. The treatment was by injection of iodoform emulsion in 10 per cent. glycerin, and not by fixation. The time of operation is important. The acute cases should not be operated on, but made quiescent by preoperative rest. The age of the patient is also very important. Generally speaking, a man over 50 years of age with tuberculosis of the knee joint is not a good subject for arthrodesis; many cases of this kind later require amputation.

I have this criticism to make of the technic described by Dr. Osgood: It appears to me to be too extensive a dissection. It seems to me important that the patient should not be subjected to a too extensive dissection, and that the operation should be quickly performed, with as little traumatism as possible. I think that some form of fixation by aid of plates or something of that kind is best, however, I had discarded it, but these statistics of Dr. Osgood seem to show that it is best, and I will now employ some means of internal fixation. I have used in the past merely one or two long nails driven through the skin below the line of incision, and up through the head of the tibia into the condyles of the femur, and left projecting. At the end of three weeks I withdraw them.

In tuberculosis in adults, I would say that there must be a sharp differentiation between the synovial type and the bony type; in the former you can often cure the condition by means

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of antiseptic injections, while in the latter resection is practically always indicated.

Dr. John Ridlon, Chicago: I should not like to have go to the general practitioners and general surgeons without a protest the statement of the apparent conviction on the part of the authors of this paper that cases of adult tuberculosis of the knee joint are not cured without operation; for I know that they are cured without operation, under prolonged immobilization and protection, the same as in children. I had the opportunity of showing such a case to Dr. Ryerson, who had doubted my statement, a year or two ago; and when he saw the patient and found how good the result was, he thought that it could not have been a case of tuberculosis. Maybe it was not; but the other knee had been excised at Johns Hopkins Hospital, the diagnosis having been concurred in by Bloodgood and Halsted of Baltimore, Gibney and Sayre of New York, and Fenger, Senn and McCarthy of Chicago.

Dr. Mark H. Rogers, Boston: This question of whether a knee recovers without operation or not in adult tuberculosis would seem to be an important one; for if such patients do recover to any great extent or in any great proportion, one does not want to do an excision in the early stage. On the other hand, if there is only probably about 1 per cent. or 2 per cent. of these cases that recover without operation, and it can be proved that they are tuberculosis, a delay in this type of case for three to five years, until there is bone destruction, will probably mean amputation and not improvement or cure. There has not yet been any record, so far as I know, of a cure by fixation. Men come to meetings and say that they have cured such cases by fixation, and that they were cases of tuberculosis; but they have not proved their results by iodoform injection. Their cure, so far as I know, has not yet been substantiated by published results; so until I see published some authentic results of careful observations, I shall still remain of the opinion that in order to get a cure, and a cure without waiting for four or five years and running the risk of having to do an amputation later, it is better to do an excision early, because there have been published authentic records of the absolute elimination of the disease by excision. If you have not obtained cures by the other methods, therefore, the earlier you do excision, the better. That is self evident. What you have to prove is that you can cure these patients without it. In a paper published last year I reviewed the records of over 100 cases. I found that, as far back as I could go, there was no record of a cure by any other method. In regard to the use of iodoform oil, I think it is too early yet to tell whether the patients so treated are cured. A good many supposedly cured cases light up later, and excision must be done. If you wait three

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or four years before excision, you have very poor tissue to do an excision on.

Dr. James Archer O'Reilly, St. Louis: In speaking of the diagnosis I do not think the paper mentioned the Wassermann test. That was probably an oversight on the part of the authors; because I do not believe that, with our knowledge of syphilis, any one would operate on the knee without having made a Wassermann test. In our clinic I could show several cases of similar conditions of the knee that got well under treatment without operation; but they were cases of syphilis, and not of tuberculosis. Therefore, I think it is very important that the Wassermann test be made.

Dr. Henry Keller, New York: I think it is worth while to mention that there are two classes of tuberculosis, the bovine and the human, and that there is a difference between them. When the infection is due to the human tubercle bacillus, the cases are resistant to conservative treatment, whereas cases of the bovine tuberculosis will ultimately recover, although it takes a few years. I think, therefore, that it is worth while to find out, before resorting to any operative procedure, whether we are dealing with a bovine or a human tuberculosis. If I were sure that I was dealing with bovine infection I should not excise. Such cases should be treated by persistent and prolonged immobilization of the affected joint or joints. I wish to reiterate that these two types of tuberculosis should differ in their treatment, because their prognosis and ultimate results differ.

Dr. Arthur Steindler, Iowa City, Iowa: I should like to ask Dr. Keller whether he has ever seen a case of adult tuberculosis of the bovine type, or has had any unimpeachable evidence of the existence of the bovine type in children.

Dr. Keller: Yes, sir; I have.

Dr. Walter G. Stern, Cleveland: I should like to ask Dr. Bull to explain his method of exploring the entire knee joint through "a simple lateral incision of 3 inches." I cannot see how such an incision will allow one to explore the top of the tibia, both condyles of the femur, etc., which is, of course, quite necessary in such an exploratory arthrotomy.

Dr. E. H. Arnold, New Haven, Conn.: One thing that stands out prominently in the paper is that fixation works very well in these cases, if it supplements excision or any other procedure, which emphasizes the point made by Dr. Ridlon that fixation is, after all, one of the means of cure, and will cover the bovine cases and the Wassermann-test cases, because in all of these it will prove beneficial.

Dr. F. J. Gaenslen, Milwaukee, Wis.: I should like to ask the essayist to go into the question of the results obtained by the Brackett method. We are all interested;

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and although he suggested that enough time may not have elapsed to allow of formulating the results, we should like to have his impressions regarding the treatment. The speaker mentioned that two weeks after the injection of iodoform oil, he began passive movements. That, I think, will impress most of us as being contrary to the principles involved in the treatment of tuberculosis; and I should like to know how he justifies that proceeding. In speaking of the tuberculin test, he referred to the local or the general reaction. I think that we should have both in all cases. One of the chief difficulties that I have had is in immobilizing the knee securely during the time the plaster is applied, whether a nail is used or not. I think that the suggestion of using a posterior splint is excellent. No mention has been made of the method that Dr. Galloway described before the American Orthopedic Association at Pittsburgh, which consists in freshening the lateral surfaces of the tibia and having periosteal bone flaps from the femur come over the denuded surface, so as to have a more secure fixation. It impressed me as a valuable help in securing early and efficient bony union.

Dr. Edwin W. Ryerson, Chicago: I have said very often that I have never seen tuberculosis of the knee get well without operation. Dr. Ridlon referred to a case that he showed me last year. It was in a woman who, many years before, had had an undoubted tuberculosis of the knee joint, which had been operated on by excision and was cured. Years later she developed what was believed to be tuberculosis of the other knee joint; but this was not proved. As I remember, Dr. Ridlon applied a plaster-of-Paris splint from the hip joint to the ankle joint, and the knee became well at the end of six months.

Dr. John Ridlon, Chicago: The knee tuberculosis in the right knee was diagnosed by Bloodgood of Johns Hopkins, and the patient was operated on there. The tuberculosis in the left knee developed while she was still in the hospital, and the diagnosis was then made by Bloodgood and Halsted. Wassermanns did not exist at that time; roentgenograms did not exist; rabbit inoculations did not exist. It was simply the opinion of the men in Baltimore, New York and Chicago whom I mentioned that it was tuberculosis of the left knee. It was treated for three or four years, and was not cured in six months.

Dr. Edwin W. Ryerson, Chicago: I think it is only fair to state that this case was not definitely proved to be one of knee joint tuberculosis. Dr. Henderson and others have said that the synovial form may be cured in adults without excision. Of course, everything is possible, and it may be that synovial tuberculosis may be cured without operation, but can a tuberculosis that is active in the bones of the adult

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knee joint be cured? Personally, I have seen no such case. It seems reasonable to believe that injections of antiseptic substances into the synovial surfaces may cure synovial tuberculosis. I have long hoped that it might do so, but I have seen many cases in my clinic in which we have injected different solutions without any result whatever, except to keep the patient wearing apparatus year after year, and then, at the end of many years, convinced that the knee was not going to get well, I have lost faith in this method of treatment. It has been an almost appalling surprise to me to find how extensive the disease is in many cases. The Central States Orthopedic Club saw in one city a large series of knee joints that had been treated conservatively for five to seven years. Not one patient was well, and all had had a stiff knee for all those years that they had been under treatment; and in my opinion, none of them stands a good chance of getting well without operation.

On the other hand, we have a simple and rapid method of producing bony ankylosis in the position best suited for the individual patient. We can reasonably expect to remove a large part of the tuberculous disease, and we can rapidly make the patient able to go about without apparatus. The majority (I will not say all) of the cases of joint tuberculosis in adults, as differentiated from synovial tuberculosis, will do better, I believe, as we see an increasing number of cases, with an excision done by a competent surgeon. Whether plates or other methods of bone fixation be deemed advisable is an open question. In my hands a long plaster-of-Paris spica from waist to toes has apparently made the patients comfortable and has promoted early union.

Dr. John Dunlop, Washington, D. C.: In reply to what Ryerson has said in regard to diagnosis, and also what Dr. Ridlon said of the early diagnosis of his case, I would say that I was Dr. Bloodgood's assistant for a year and saw a great many of the pathologic knees that were excised. After the possibility of a diagnosis of chronic joint disease became known, which it was not when I worked in the laboratory, they went over all those old excisions that they had made at Johns Hopkins and found that the diagnosis of atrophic arthritis was always being made in place of the diagnosis of tuberculosis. I believe that the case that Dr. Ridlon referred to was one of atrophic arthritis, although at that time all the men in Baltimore were making the diagnosis of tuberculosis in such cases.

Dr. Edward C. Bull, Boston: There seems to have been a misunderstanding. Our statement was that we have seen no recovery of adult tuberculosis of the knee without operation—meaning to include as an operation the injection of iodoform oil. At the time of the dissection of the involved tissues no effort is made to get the diseased portion out com-

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pletely, but to get out most of the synovia and diseased bone. The Wassermann, gonococcus complement fixation and tuberculin tests are made as a routine; syphilis is therefore eliminated. As to the 3-inch incision in the oil arthrotomy operation, we grant that we cannot get a complete view through this; our observations are based on what we can see and feel, the fingers being run around to break up adhesions. Passive motion is employed very conservatively at first. The capsule is quite distended under the pressure of the oil, so there is little rubbing of the synovial surfaces, and certainly no force is used in the earlier employment of passive motion. Only a very few degrees of motion are employed at first.

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CEREBRAL SPASTIC PARALYSIS DUE TO HEMORRHAGE

A FURTHER REPORT OF THE FIRST SIXTY-FIVE CASES OF CRANIAL DECOMPRESSION FOR SELECTED CASES *

WILLIAM SHARPE, M.D.

AND

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NEW YORK

The patients were carefully selected, and only those with signs of persistent intracranial pressure were chosen, this constituting less than 25 per cent. of those examined. Ophthalmoscopic examination revealed dilated retinal veins and blurring of the optic disks; in the later cases, these findings of increased pressure have been confirmed by the measurement of the cerebrospinal fluid at lumbar puncture by the use of the spinal mercurial manometer. In all of the cases there was a history of prolonged and difficult labor, most of them being instrumental deliveries. A negative Wassermann test of both blood and spinal fluid was obtained in every case except one. No selection was made as to age, spasticity or mental deficiency. Microcephalic children, cases of agenesia (so-called Little's disease), and those due to meningo-encephalitis were naturally excluded as nonoperable, there being no increased intracranial pressure.

The pathologic condition, as found at operation and and post mortem, was noted, a written permission for necrospy having been obtained in each case. A definite fibrous cystic formation was invariably pres-

* The preliminary report of this work appeared in THE JOURNAL, Feb. 6, 1915, p. 482.

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ent. This lesion was supracortical in all but four cases, the others being subcortical or cortical. The cysts were punctured and their outer walls removed; fibrous formation was removed except in cases in which its removal would have caused damage to the underlying tissue; in these cases it was left alone.

After-treatment consisted in the correction of deformities by tendon lengthenings, stretching of muscles, tendon transplants, etc., massage, and careful muscle education with special attention toward establishing an improved coordination.

Of the sixty-five patients, nine died after operation, and eight have died in the past two years, making a total of seventeen deaths. We have been unable to obtain any record of four; nineteen show practically no change; twenty-five show improvement more or less marked; the youngest patient was 2½ years of age, and the oldest 17 years.

When epilepsy is a complicating factor, the prognosis is invariably bad; the immediate results were gratifying in that the convulsive seizures were less frequent, but this improvement lasted only for a few months. The younger the child, generally speaking, the more marked has been the improvement. The older the child, the less marked the improvement. In the adult cases there has been practically no improvement. Supracortical lesions are the only favorable cases; in this type damage to the nerve cells is due to pressure alone from the overlying lesion. In the cortical or subcortical lesions, there is, naturally, a definite destruction of brain tissue, and only in those cells along the edges of the cyst that are suffering from pressure can any improvement be expected.

CONCLUSION

We want to make an appeal for better preventive means in avoiding this most distressing affliction. First of all, we need more care on the part of the obstetrician; careful pelvic measurements should be

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made as early as possible; prolonged labor should be avoided whenever possible; practitioners should realize that cesarean section is less dangerous to mother and child than is the use of the high forceps; every child should be as carefully inspected during the first few weeks of life for symptoms and signs of intracranial hemorrhage as for deformities. When these symptoms and signs are present, a cranial decompression operation should be performed as early as possible in those selected cases in which the fluid or clotted blood can be removed before any (or but little) permanent damage to the brain tissue has taken place. In this manner we believe that children suffering from this form of spastic paralysis can be reduced in number, and that the most severe cases can be avoided or improved. The essential points to be emphasized are the early diagnosis and early treatment of these selected cases.

ABSTRACT OF DISCUSSION

Dr. Fred J. Fassett, Seattle: We have, in previous times, seen promises given for the relief of such deplorable conditions, and have had good reports from the treatment up to a certain point, and there the matter has apparently dropped. I think that when it has been shown that a remedy that seemed promising at first has later become less promising, there is a tendency to drop the subject on the part of those who have introduced it, thus leaving the rest of us in the air, so to speak, as to the ultimate results. We are asked often what the final outcome was in such cases, and are compelled to answer that we do not know. We in the West have sometimes seen patients who have traveled thousands of miles to be treated in some new way, only to find out that had the later results been published, the trip would have been unnecessary. I wish, therefore, to commend the frankness with which these gentlemen have reported to us this definite conclusion of their work.

Dr. William Sharpe, New York: Dr. Farrell and I have endeavored in this report to be as conservative and as critical in regard to the results in these first sixty-five cases as one could possibly be. The point we wish to emphasize is that most of these patients over 3 years of age are derelicts, and no marked improvement can be expected in many of them. These extreme cases can be somewhat improved, but

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the improvement, as you see, in many of them is slight. Indeed, in only twenty-five out of our first sixty-five cases, which were of the most extreme type of the condition, can we say that the operation was justified by the results obtained.

We wish also to emphasize the fact that the cases should be diagnosed early—as soon as possible after birth—by means of careful ophthalmoscopic examinations, a measurement of the pressure of the cerebrospinal fluid at lumbar puncture by means of the spinal mercurial manometer, blood and spinal fluid Wassermann tests, etc. By selecting these patients carefully and operating only on the ones with increased intracranial pressure can we expect to obtain definite results. I have now operated on nine of these infants on the day after birth, with excellent results. Only about one out of every five patients examined has shown signs of increased intracranial pressure, and naturally only these selected patients were operated on.

I wish also to emphasize the importance of getting permission for necropsy in this work. Of the 282 children I have now operated on out of almost 1,400 children examined, we have had permission for necropsy in every case before the operation, and of the twenty-eight children who died we found the intracranial hemorrhage in all but one of them. In the early cases we can get excellent results; but in the wrecks or derelicts of several years' duration, very little can be expected in the way of a marked improvement.

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RESULTS OF THE TREATMENT OF OBSTETRIC PARALYSIS *

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BOSTON

In obstetric paralysis one sees two types of cases: the so-called upper arm type in which the muscles involved are generally the deltoid, the supraspinatus and infraspinatus, the teres minor, the triceps, and biceps, and the supinator longus; and the whole arm type, in which all the previous muscles are involved as well as all those below the elbow, including generally most of the muscles of the hand. The conditions found in the upper arm cases are due to injury to the fifth and sixth cords of the brachial plexus and the suprascapular nerve, at or about Erb's point, that is, where the fifth and sixth cervical cords join. The second type is generally due to nerve injury of a more extensive type, involving all the cords of the plexus, and often the first thoracic cord.

CAUSES

The cause of obstetric paralysis is practically invariably the injury to the brachial plexus, as a result of overstretching during labor. The labor is generally a long and difficult one, and the child may be unduly large. Asphyxia of the baby from ether is a frequent predisposing factor.

A study of Table 1 will show the conditions existing at birth, so far as could be determined, as well as the tabulation of the other conditions.

* From the Neurological and Orthopedic Departments, Children's Hospital, Boston.

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It has been conceded by all writers with adequate knowledge of the subject that a difficult labor is a predisposing factor in the causation of the paralysis. In this series of cases 452 were definitely recorded as having had long, laborious and difficult labor; 385 had ether, and 335 had forceps applied; thirty-four were apparently normal labors, and 114 were recorded in which the child was asphyxiated. All the conditions noted above imply the application of force combined

TABLE 1.—CONDITIONS EXISTING AT BIRTH IN FIVE HUNDRED AND NINE CASES

Boys	254
Girls	255
Right arm affected	292
Left arm affected	201
Both arms affected, upper arm type	4
Both arms affected, lower or whole arm type	1
Both arms affected, type not noted	6
Upper arm type	426
Lower arm type	72
Difficult labor	452
Ether used	385
Forceps used	335
Normal labor	34
Asphyxiation of child	114
Head presentation (including face)	238
Breech presentation (including foot and version)	77
Position not known	188
Fractured clavicle	15
Arm broken	4
Cord around neck and arms	3
Cord around neck	2
Pupils unequal	19

with great muscular relaxation of the child, which conditions are peculiarly favorable for the production of such an injury. A moderately large number, it was noted, had the head delivered naturally, but the shoulders stuck, and in that time force was applied. It should be noted that in regard to the presentation, 238 were vertex or face presentations and seventy-seven were breech. The latter classification includes versions and footlings. In 188 the presentation was not known, but probably a large majority were vertex. These figures do not bear out either Tubbey or Sherren (quoted by Fairbank) who state that the paralysis usually occurs equally in head or breech presentations.

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The pathology of these lesions will not be gone into except to state that all observers who by operation or necropsy have examined the plexus have always found definite nerve injury to account for the clinical picture. The question of primary injury to the shoulder joint has been discussed and defended as an etiologic factor in these cases, but it is purely philosophical and has never been backed up by pathologic proof, and in no way accounts for the clinical pictures which are the result of nerve injuries definitely localized, which cause the characteristic paralytic muscle grouping.

All cases tend toward partial recovery. This is true more in the upper arm type of case than in the whole arm type. In the upper arm type I can recall no case out of several hundred (509) which has failed to show a good return of muscle power in the muscles originally affected, and this power becomes greater under treatment and in some cases nearly approaches normal. With the return of power and relief of contraction and deformities a very nearly normal arm is obtained in some cases (Table 2).

In the whole arm type these conditions do not hold. Usually, however, the upper arm will make a good recovery, and with the relief of contractions and joint subluxations will prove to be very useful. The lower arm and hand, however, rarely recover under any treatment, and usually remain in nearly their original condition. This is due undoubtedly to the severity of the nerve injury, especially of the lower cords of the plexus.

DEFORMITIES PRESENT

The usual deformities present are contraction of the adductors and internal rotators of the humerus, and posterior or anterior subluxation of the shoulder joint, with a hooking down of the acromion in the older cases. This acromial deformity, however, does not occur except when there is a posterior subluxation of moderate degree, sufficient at least to remove the head of the humerus from its normal position enough

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TABLE 2.—ANALYSIS OF 394 CASES OF OBSTETRIC PARALYSIS, SHOWING CONDITION AT DIFFERENT AGES, AGE WHEN SIGNS OF RECOVERY WERE NOTED, AND IN THE OLDER PATIENTS THE CONDITION ON ENTRANCE TO CLINIC

Age	Complete Paralysis		Partial Recovery		Total Recovery		Elevates to Shoulder or Above		Wrist Drop	Paralysis of Hand Partial or Complete
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower		
2 wks.	11	..	..	..	..	..	..	..	..	..
3 wks.	5	..	4	..	..	..	1	..	..	..
5 wks.	7	..	7	..	..	..	..	..	..	..
6 wks.	3	1	2	1	..	..	..	..	1	1
7 wks.	7	..	7	2	..	..	1	..	..	..
2 mos.	8	2	14	..	1	..	6	..	..	..
10 wks.	1	..	7	..	..	..	4	..	..	..
3 mos.	3	3	27	1	..	..	10	1	2	..
4 mos.	..	..	12	1	..	..	6	1	1	1
5 mos.	..	1	9	..	..	..	7	..	..	..
6 mos.	..	..	15	1	..	..	15	1	1	..
7 mos.	..	..	10	..	..	..	9	..	..	..
8 mos.	..	3	11	3	..	..	9	1	3	3
9 mos.	..	..	12	..	..	..	11	..	..	..
10 mos.	..	..	3	..	..	..	2	..	..	..
1 yr.	..	..	48	7	1	..	47	5	6	4
2 yrs.	..	..	27	5	..	..	26	3	5	3
3 yrs.	..	1	16	2	..	..	15	1	3	3
4 yrs.	..	..	19	2	2	..	19	2	2	1
5 yrs.	..	..	7	2	..	..	7	2	3	1
6 yrs.	..	..	12	2	1	..	12	1	2	2
7 yrs.	..	1	6	2	..	..	6	2	3	2
8 yrs.	..	..	8	..	1	..	7	..	..	..
9 yrs.	..	..	4	..	..	..	4	..	..	..
10 yrs.	..	..	3	..	1	..	2	..	..	..
11 yrs.	..	..	6	1	..	..	7	..	1	..
12 yrs.	..	..	2	..	..	..	2	..	..	..

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so that it no longer acts as a buffer to the acromion. This deformity never occurs in young children, but is seen only in the older patients, that is, in the cases of at least a year's duration, and generally not markedly then.

The reason the adductors and internal rotators are contracted is that their opponents are paralyzed temporarily, and when they partially recover spontaneously are not then strong enough to overcome the contractions. Certain cases show late, that is after several years, a partial dislocation of the head of the radius due to the paralysis of the spinators and the recovery of the biceps.

These children cannot abduct the arm well, cannot elevate as a rule to beyond the shoulder level, and cannot supinate more than one half normal. In the whole arm type of case the patient cannot do any of these things, as well as having a loss of power in the hand and fingers and a wrist-drop. The fingers are generally hyperextended at the first phalanx and flexed at the others.

TREATMENT

It is my firm belief that the immediate prevention of deformity is the only and natural way to treat these cases. Therefore every patient of whatever type should have the arm placed on a splint or in a cast with the arm elevated to the shoulder level, abducted, outwardly rotated, and fully supinated.

Massage and exercises should be given with the arm off the splint, and the splint should be worn night and day for several months. The massage and exercises should be persisted with for several years. In the older patients seen for the first time, contractions will always be present, with or without more or less joint subluxation and acromial deformity. These may be dealt with by stretching under ether and the application of a splint or plaster, or by operation, whichever method seems best indicated. In either way the arm may be improved.

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Fig. 1.--Skin incision and isolation of pectoralis major. Cephalic vein at outer edge of pectoral. Arm abducted and rotated out.

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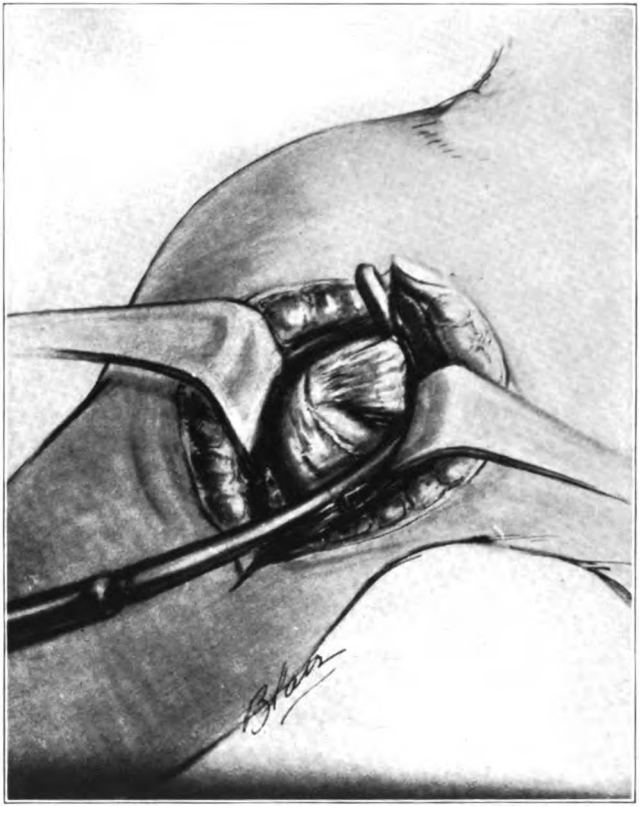

Fig. 2.—Sound under subscapular tendon. The pectoralis mapor has been divided. The joint capsule shows at bottom of cavity.

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Fig. 3.—Before operation: Patient unable to supinate right arm.

Fig. 4.—Same patient before operation: Unable to rotate right arm outwardly.

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Fig. 5.—Same patient after operation: Able fully to supinate right arm.

Fig. 6.—Same patient after operation: Able fully to rotate right arm outwardly.

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Fig. 7.—Before operation: Patient unable to rotate right arm outwardly.

Fig. 8.—Same patient viewed from the side: Unable to abduct right arm fully.

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Fig. 9.—Same patient after operation: Full outward rotation and supination.

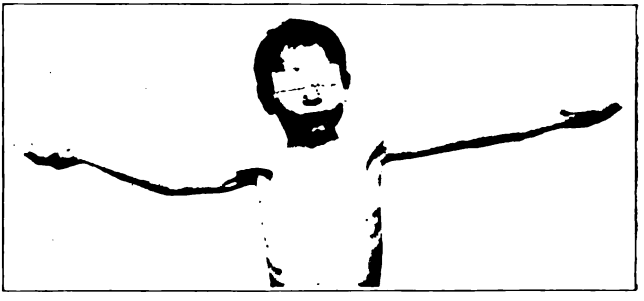

Fig. 10.—Same patient after operation: Free supination of right arm.

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The gain made by the proper use of a cast or splint is always marked, and the time saved is great. No amount of exercise or massage alone will stretch the internal rotators. Fixation in a position which stretches them constantly is essential. The earlier this is done the fewer the cases which will come to operation later for divisions of muscular contractions.

Before describing the operation which I have been using the last two years, I wish to speak of the Lange method of operation. This consists of an osteotomy of the shaft of the humerus at about the insertion of the deltoid, and the rotation outward of the lower fragment, so that a condition of permanent outward rotation of the lower segment of the humerus is established. This gives a good useful arm so far as supination is concerned, but does not affect the conditions at the shoulder joint, and also limits future inward rotation of the arm.

The method that we have used at the Children's Hospital is as follows:

An incision (Figs. 1 and 2) is made along the upper and anterior aspect of the humerus with the arm abducted and outwardly rotated. This incision is carried from just below the acromion to about 1 inch below the lower edge of the tendon of the pectoralis major, which is dissected so as to define it clearly, and then cut near its insertion. After the cut end of the pectoral has been turned back, the coracobrachialis comes into view. The outer edge is defined, and just below the joint level the outer edge is cut across for about one quarter inch. This allows better retraction inward of the muscle, and brings easily into view the subscapula tendon at its point of insertion into the joint capsule. The arm during the operation is held abducted, outwardly rotated, and elevated to the level of the shoulder. The deltoid and cephalic veins are retracted out so as to give adequate room. The subscapula tendon is then isolated and cut on a director, care being taken to avoid opening the joint capsule.

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Once this tendon is divided, the limitation to full and free outward rotation is gone. The arm is then put on a splint maintaining the corrected position and held there for about ten days, or until the wound is healed and the soreness gone, when massage, baking and exercises are started. If an osteotomy of the acromion is needed to allow reduction of joint subluxation, it may be done through the upper end of the incision.

Up to date there have been about thirty patients operated on. Most of them have had the operation described above; one has had the Lange operation with a good result. Others have had simply osteotomy of the acromion plus reefing of the posterior portion of the joint capsule. A number have had the joint capsule opened and too long fixation.

The results have been on the whole good. Outward rotation and supination have been restored. Adduction is slow in coming back, but does so eventually. Elevation of the arm is improved, through recovery of strength in the deltoid. The child can get the hand to the mouth, on top of the head, and back of the head in practically all cases after operation, which is a great gain, especially in girls.

In certain cases in which there had been an osteotomy of the acromion and a plaiting of the capsule the patients were not benefited, because the contractions of the internal rotators were not divided. In those cases in which the joint capsule had been opened, it was very difficult to restore motion in the shoulder joint. There was practically always a partial ankylosis of the shoulder joint, fixing the arm in abduction, outward rotation and elevation. This condition, owing to the impossibility of fixing the scapula, was very difficult to overcome, and so far has not been overcome adequately in any of the cases, even at the end of a year. Too long fixation at first may have helped to insure this bad result, and now we are fixing these cases only long enough to allow the wound to heal, and are keeping outside the joint capsule. I might add

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that the only way to keep out of the joint capsule is to make a careful dissection, isolate the tendon of the subscapula, and divide it extra-articularly. This is of the greatest importance and cannot be too strongly insisted on, if one cares anything about good results.

The duration of the after-treatment is of importance. The splint should be worn night and day for at least three months, and longer if necessary in individual cases. The massage, baking and exercises should be done daily if possible, and at least four times a week for at least a year, as the best results are commensurate only with adequate after-care, which is of more importance than the operation, in that without after-care, the operation would probably do no good.

In addition, it might be stated that as no adequate test of the strength of the deltoid is possible before operation, it cannot be definitely determined just how much power it will have in elevating the arm after it has been freed from mechanical restriction. To say that the deltoid will be better able to do what work it is called on to do, and will probably do more than it has been able to do before, is a fair statement, and it has been seen to increase to nearly normal strength as compared with the unaffected side, even after eleven years' complete disuse, in the space of a few months. Careful massage and muscle training plus support will go a long way toward restoring power, provided there is no definite loss of nerve impulse.

In conclusion I might say that the operation is apparently well conceived, is not dangerous, does good when well and properly performed, and that the after-care is most essential.

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ABSTRACT OF DISCUSSION

Dr. John Dunlop, Washington, D. C.: Dr. Sever operated on a patient in such a case as this before the American Orthopedic Association last year at Washington. I inquired about the patient recently and have the report of her condition. She has done well. Her mother has been careful

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in following out the after-treatment with active and passive exercise. The child can touch her head and dress her hair easily, and has good supination. I think it is important to prepare the cases for proper muscle training. We should educate the mothers properly at an early period, so that a good result may be obtained by passive and active exercise. The important part of the work is proper supervision of the exercises. In our cases and in the case in which Dr. Sever operated last year before the American Orthopedic Association a great deal of improvement has been obtained by this line of treatment.

Dr. A. S. Taylor, New York: I feel that there are one or two things that should be said concerning nerve repair in conjunction with Dr. Sever's work. It has been my experience in seventy-five or eighty operative cases to find scarcely two lesions alike; and it is also true that it is almost impossible, in the early weeks of life, to determine what extent of damage has occurred in the nerve roots. It is possible to have complete temporary loss of function in all the muscles of the extremity and yet have only very slight injury of the nerve roots. It is usually the case that the upper roots are the ones that suffer most. These may be completely torn away and their ends separated from each other so that it would be impossible to have regeneration occur spontaneously. At the same time the lower roots have been damaged sufficiently by stretching, pressure, etc., to have been temporarily put out of commission. The stumbling-block as to the course of treatment is that, because improvement begins in the muscles controlled by the lower roots (and spontaneous improvement occurs in the majority after a short time), practitioners say, "Nature is doing something; let us wait and see what she will accomplish." Perhaps there will be almost complete return of power in the lower three roots, but if there has been severance in the upper two roots there can be no improvement in these; and during the wait for improvement in the lower roots, valuable time is lost that could have been used for nerve repair of the upper roots, and the deplorable deformities occur in the later years that are seen in Dr. Sever's pictures. For this condition the operation that he has devised is most satisfactory.

I would make a plea, from the standpoint of neurologic surgery, that the lesions be explored early so that one may know the type that one is dealing with. If one explores and finds nothing to do to the nerve roots, one has merely made an incision 2 inches long through the skin and a little of the subcutaneous fat. One has been able to see and palpate and test with an electrode the nerves that have been injured. If nothing is found to repair surgically, no harm has been done beyond a simple skin incision. If damage to the roots is found, then one is able to repair it at a time when there is

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the best chance for the child, and while getting spontaneous improvement in the lower, there is also occurring a return of function in the upper roots as the result of the surgical interference. By nerve repair in older cases, there has never been a perfect physiologic or anatomic result. One of the reasons for that is that when muscles are allowed to go for three or four years without functionating, the bones do not develop properly and abnormal shapes in the joints result, so that when nerve function is finally secured there is, between abnormal joints and contractures of muscles, an amount of deformity that no nerve surgery can overcome. While there is improvement in the function of the arms, there has been neither a complete anatomic nor a complete physiologic return.

Dr. J. A. Nutter, Montreal, Canada: During the past two or three years Dr. Sever and I have had many conferences on the subject of his operation, and I have given it a good trial at the Montreal General Hospital. The best result that I have had in obstetric paralysis has been one in which this operation was employed.

There is one question that I should like to ask Dr. Sever, and that is this: I find some difficulty in determining just when one should operate in these cases, and when one should simply stretch the contracted muscles. I should like to ask Dr. Sever what rule he follows in determining when one should have recourse to the knife, and when merely stretching is necessary.

Dr. John Joseph Nutt, New York: I should like to ask Dr. Sever whether, when he removes the apparatus, ten days after the operation, he continues to reapply it after massage; and if so, for how long.

The question that Dr. Nutter asked, I also had in mind. It is not clear to me how dividing the pectoralis major or any other muscle about the shoulder can affect flexion at the wrist, except by encouraging supination.

Dr. James W. Sever, Boston: I am a firm believer in early operation, but the trouble is that we do not get the cases early. We are trying to get the people educated, and during the last year or two they have been bringing the children to us earlier than formerly.

This series covers 509 cases, more than the number reported by all observers since the time of the first description of the condition.

In regard to the question of nerve repair, I would say that according to Prout's Pathology the nerve sheath is the thing that repairs first, and thus makes scar tissue along the course of the nerves that have been torn; and there is apt to be constriction of nerve impulses, if not complete obstruction of the nerve path, although usually there are some fibers going through the scar tissue.

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So far as the plexus is concerned, no two cases are alike, and it is difficult to make an anatomic repair of the plexus, and when the nerves have been evulsed from the spinal cord it is impossible.

Dr. T. T. Thomas of Philadelphia based his report on six cases in children averaging 9 years old. I have seen a great many of these children, and in no case has there been any posterior subluxation of the shoulder. Dr. J. J. Thomas of Boston and I have looked at them together, and in no case has there been acromial deformity, on which Dr. T. T. Thomas laid stress, except in older cases that had been neglected.

With regard to stretching, I would say that I have used it in a certain number of cases, but have found it of very little value. One cannot fix the scapula. If one could nail it to the ribs it might be all right; but the minute one lets up, the contraction recurs in spite of the most careful treatment.

Dr. Nutt asked about the use of apparatus. In the patients operated on several years ago we placed a plaster spica on after operation and left it on for months. The patients, however, did not do well, and adhesions occurred about the shoulder joint, and one or two of them, to this day, are failures, although the parents believe that these children are improved. The result, however, is a practical ankylosis to the scapula, and it is not a satisfactory result.

The splint is put on and is kept on for ten days. As soon as the wound has healed and the soreness is gone, baking and massage are begun and repeated several times a week for six months or a year. The child wears the splint night and day for eight months. It is not the operation that cures, but the careful carrying out of the after-treatment.

The things that are hardest to get eventually are abduction and internal rotation. Gravity will help to get them. The development of the rhomboid and of as much power as possible in the deltoid are the things that will help.

It is obvious that when there is complete nerve division there is nothing to be expected.

With regard to improvement of wristdrop, that comes more from increased function and supination and the taking up of the stretch of the dorsal muscles of the forearm.

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PAIN IN THE ARM: SUBDELTOID (SUBACROMIAL) BURSITIS

A FURTHER STUDY OF ITS CLINICAL TYPES, PATHOLOGY AND TREATMENT

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The statement may appear bold, even to a gathering of orthopedists, that most of the cases of persistent pain in the upper arm, so often treated for "rheumatism" and "neuritis," are surgical affections, at least in that they require mechanical treatment.

In the absence of arthritis or of symptoms in other parts of the body, the diagnosis of rheumatism, as an explanation of pain in the arm, is quite untenable, and need not detain us.

Brachial neuritis is a real condition but a comparatively uncommon one. When well established, it should be marked by motor, trophic or sensory signs, as well as by nerve tenderness. In all cases it is important to determine, by careful examination, including roentgenography, whether the neuritis is not simulated or produced by some other lesion. Pain in the left arm, usually referred especially to the flexor aspects of the elbow and wrist, may be associated with an anginal condition and, as such, may be symptomatic, among other things, of tobacco poisoning.

Of the surgical conditions, aside from grosser and more evident lesions, that cause pain in the arm, we must bear in mind cervical rib, fracture of the greater tuberosity of the humerus (which may occur from comparatively mild internal as well as external violence), spontaneously reduced luxation of the shoulder,

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subluxation[1] of the shoulder (either of which may be produced, in some persons, by slight violence), mild sprain of the shoulder, periostitis of various origin, and neoplastic and inflammatory diseases of the bones, especially the humerus (among which chronic bone abscess, cortical or medullary,[2] should be mentioned as an occasional cause of severe, persistent pain).

Far more common than any or all of these causes of pain in the arm and sometimes, but by no means always, also in the shoulder, is subdeltoid (subacromial) bursitis. It is, indeed, so often the cause of the complaint, that it should be thought of first.

In earlier communications[3] concerning the pathology, pathogenesis and operative treatment of subdeltoid bursitis, I presented the conclusions reached by several years of observation. These have been so much misquoted that I wish to restate and further elucidate some of them; and, especially, it is my purpose to describe the affection in its various clinical aspects, its nonoperative treatment and what I believe to be the indications for operation. I shall exclude from consideration the uncommon tuberculous and metastatically suppurative subdeltoid bursitides.

ETIOLOGY

Although a history of injury or of muscular violence is often unobtainable, I believe that the immediate cause of subdeltoid bursitis is traumatic, usually a squeezing of the supraspinatus tendon (occasionally the infraspinatus) and the bursa between the acromion process and the greater tuberosity of the humerus when the arm is abducted. This injury may, and

1. Brickner, W. M.: Traumatic Forward Subluxation of the Shoulder: A Clinical Entity, Am. Jour. Surg., February, 1915.
2. Brickner, W. M.: Chronic Medullary Abscess of the Long Bones, Ann. Surg., April, 1917.
3. Brickner, W. M.: Prevalent Fallacies Concerning Subacromial Bursitis: Its Pathogenesis and Rational Operative Treatment, Am. Jour. Med. Sc., 1915, **149**, 351; Shoulder Disability: A Further Study of Its Varieties and their Treatment, Interstate Med. Jour., April, 1915; The Location and Cause of Lime Deposits Associated with Subacromial Bursitis: "Excision of the Bursa," Am. Jour. Surg., April, 1916.

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often does, happen from a fall on the outstretched arm or other external violence. More often it happens from internal violence, as in raising the arm to beat a rug, hanging from a car strap, etc. This squeezing of tendon and bursa between the bony surfaces is easily demonstrable at operation or on the cadaver by abducting the arm. In operation in acute cases, recent hemorrhage into and tear of the tendon are plainly to be seen. Codman[4] reported three cases, and demonstrated, by operation in two of them, complete rupture of the supraspinatus tendon and tear of the bursal floor, from internal violence. Bucholz[5] also reported a case, likewise demonstrated at the operation.

Small fractures of the greater humeral tuberosity, which, as I have said, may also be produced by muscular violence, are probably also associated with inflammation of the overlying subdeltoid bursa (which accounts in part for persistence of the shoulder disability after this injury, if it is not treated, as it should be, by abduction). Indeed, the lesion is much the same as subdeltoid bursitis without fracture — in one case there is a tear of the supraspinatus tendon above its attachment, and in the other, a tear through its bony attachment.

I believe there is another etiologic factor, at any rate as far as concerns the commonly, but by no means always, associated subbursal deposit of lime and other mineral salts in or on the supraspinatus (occasionally the infraspinatus) tendon. This factor is some metabolic predisposition to the deposit of these mineral salts. I am of this belief for the following reasons: As far as I know, subdeltoid bursitis occurs only in adults (in my cases, between the ages of 20 and 61); it occasionally is encountered first in one

4. Codman, Ernest: Complete Rupture of the Supraspinatus Tendon: Operative Treatment with Report of Two Successful Cases, Boston Med. and Surg. Jour., 1911, **164**, 708.

5. Bucholz, C. H.: Therapeutic Exercise and Massage, Philadelphia, Lea & Febiger, 1917, p. 231.

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shoulder, then in the other; in some persons the deposit (or deposits) undergoes absorption, in others it persists; although a common affection, many persons using their arm in the same way, and subjected to the same influences, never develop it; it occurs among the muscular and athletic as well as the sedentary and asthenic, in females as well as in males; no other hypothesis explains why in some persons, within a day or two after a mild internal violence or an external injury, the roentgenogram will reveal this characteristic deposition of lime above the greater tuberosity of the humerus.

I have reason to believe that subacromial bursitis is neither infectious nor toxic in origin. Tissue specimens removed at operation in acute as well as in chronic cases proved sterile. Even the sometimes liquid deposits often indistinguishable in appearance from pus contain no pus cells — only mineral salts, fat cells and detritus. Although in the acute stage there is sometimes a subfebrile elevation of temperature, I have not found, in the more than 200 cases I have seen, any coexistent infection, nor have I been able to connect the lesion with any antecedent infection, tonsillar or otherwise.

I confess that my hypothesis of trauma and a biochemical predisposition as an explanation of subdeltoid bursitis and the subbursal lime deposit leaves much to be desired. What the metabolic fault is I have not learned. (It is a difficult laboratory problem.) Certainly there is no clinical evidence of gout. The occurrence of these lime deposits, and, indeed the bursitis itself, have no exact analogue elsewhere in the body. It is a curious, and curiously common condition, and affords an interesting field for speculation and investigation.

PATHOLOGY

In all of the eighteen patients I have operated on, I found the same lesion in the bursa — adhesions between its two walls. These adhesions may be mod-

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erately long, or short and dense, gluing the two surfaces together over a limited area. They are always demonstrable if the operator is careful not to do what so many, I am sure, have done, namely, cut through the adherent floor and roof of the bursa with one incision. Beyond the area of adhesions, which is usually in the region of the greater tuberosity, the bursa can be freely entered with finger or instrument, and its free surfaces can be demonstrated. Here and there the bursal wall is sometimes thickened, but usually not much so. I have not encountered "villous" thickenings referred to in Codman's[6] article. Sometimes there is a small amount of serum. This I have found locked in the subacromial portion of the bursa by the adhesions below it, and it is liberated when these are divided. In most cases, I have found no fluid accumulation in the bursa. Probably there is always a serous effusion at the outset, but it usually soon disappears.

The lime deposit is not in the bursa, or in its walls. It lies under the bursa, either wholly within the supraspinatus tendon, or on it, or partly within and partly on it. The tendon may have to be split to reveal the deposit or deposits, or the calcareous mass may be plainly seen lying in the tendon. Occasionally the deposit is in the infraspinatus tendon. Sometimes it will be found scattered about on the periosteum in the neighborhood of the greater tuberosity. Irrespective of the severity of the symptoms, the deposit may be small or large, dry and gritty or semifluid, single or multiple, near the insertion of the tendon or at a considerable distance from the tuberosity (Figs. 1 to 6). In early cases, there may be plainly seen a small transverse tear in the tendon near its termination, and a hemorrhage into the neighboring tendon tissue. The histology of the tendon lesion and of the

6. Codman, Ernest: Bursitis Subacromialis, or Periarthritis of the Shoulder Joint, Boston Med. and Surg. Jour., 1908, 159, beginning October 22.

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lime formation has been studied from my cases, and adequately described, by Moschcowitz.[7] The lime deposition takes place, it would seem, as a result of necrosis of tendon tissue.

It can be seen from Figure 7 why so many surgeons have felt sure that they found the lime in the bursa. If the two bursal walls, adherent over the deposit, are divided at a single incision, the surgeon, believing he has cut only through the outer wall or "roof," will expose the lime mass, unless it is concealed in the tendon; on removing this mass he will encounter the broad supraspinatus tendon, which he believes to be the inner wall of the bursa. If, however, the operator will lift up the outer wall with tissue forceps and incise it carefully, and then divide the adhesions between it and the bursal floor, he will find that he can explore the interior of the sac without encountering the deposit. The latter will not be exposed until he has then separately cut through the inner wall or floor of the bursa, and not even then if, as is very common, the deposits are quite within the tendon.

I would emphasize again that the lime deposit takes place, not slowly, but very speedily after the injury. In some cases it is slowly absorbed; in others it persists for years, perhaps for life. This, too, suggests some biochemical influence.

SYMPTOMS

The symptoms of subdeltoid bursitis are two: pain, and disability in shoulder movements.

Pain is present in almost all cases. It is usually referred to the upper arm, anteriorly or externally, from the level of the deltoid insertion toward or to the elbow. Very often, but by no means always, it is referred also to the shoulder, usually its outer aspect. Sometimes it radiates into the forearm, the

7. Moschcowitz, Eli: The Histopathology of Calcification of the Spinatus Tendons as Associated with Subacromial Bursitis, Am. Jour. Med. Sc., July, 1915.

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hand, the fingers or the neck. The pain may be fairly constant, or intermittent, or only on motion. Often it is worse at night.

Disability of movement may be entirely absent, especially in chronic cases. In the early stage, however, abduction, at least, is inhibited or painful. This movement and internal rotation are chiefly affected, but in varying degrees. The patient may be able to raise his arm only a little, or he may be able to abduct insufficiently to brush his hair. The interference with internal rotation may be very great or moderate; the patient may be unable to put his hand in his trousers pocket, or unable to reach behind his back, or unable to raise his hand on his back to the opposite scapula. External rotation is usually little affected, but sometimes is much inhibited. The arm can be swung backward and forward. There is no ankylosis.

PHYSICAL SIGNS

In the early stage there may be slight swelling due to serous effusion. In most cases, when the patient presents himself there is no swelling. On the contrary, there is often to be noted a flattening, due to atrophy of the deltoid. The supraspinatus and infraspinatus muscles may also be atrophied. Pressure on the bursa below the tip of the acromion process is sometimes painful, but it is usually painless. The only tender point that I find quite constantly is anteriorly, over the lesser tuberosity. When this point is very tender (comparison should be made with the opposite shoulder) it is fairly diagnostic in association with the symptoms described.

Roentgenography is important. If nothing is shown, it does not deny, rather it supports, the diagnosis of bursitis. If the shadow of a lime deposit is seen, however small it may be, the diagnosis is established beyond doubt.[8] Finally, the roentgenogram may

8. Occasionally the tendon lesion exists without an overlying bursitis, but the symptomatology and treatment are the same.

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show some unsuspected lesion, namely, syphilis or tuberculosis of the head of the humerus, or a small fracture of its tuberosity (the latter, as I have said, clinically the same lesion as supraspinatus injury and, like it, probably also having a bursitis associated with it).

CLINICAL FORMS

Codman's[6] classification into three types, "acute or spasmodic, subacute or adherent and chronic or nonadherent," is unsatisfactory from the anatomic side, for in all cases, acute or chronic, the pathology is, I believe, the same — an adhesive bursitis. We cannot recognize, therefore, a nonadherent and an adherent type, nor it seems to me, can we make a satisfactory distinction under the titles "subacute" and "chronic."

In my experience the cases present themselves in the following forms which, however, are not to be sharply separated: acute, "hyperacute," chronic, chronic with exacerbations.

In acute cases, pain and stiffness develop rapidly and reach a maximum in about three days. The pain is quite severe and constant, and subsides little or not at all at night. The arm can be only slightly abducted without great pain. There is spasm of the shoulder muscles, increased by attempted abduction or internal rotation, active or passive.

The term "hyperacute" I use to indicate not so much the rapid development of the symptoms as their severity. The pain is very great. The patient hugs his arm to his chest, and the slightest attempt to raise it causes severe spasm. There is a rapid development of atrophy of the deltoideus and the spinati. Radiation of the pain into the fingers, with this atrophy, may deceive even a neurologist into the diagnosis of brachial neuritis. Indeed, the early appearance of atrophy of these three muscles suggests that there may be some associated localized neuritis; disuse for a short period seems not quite sufficient to explain it.

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In both the acute and the "hyperacute" forms, tenderness at the point I have described is exquisite.

Acute subdeltoid bursitis may gradually subside completely. More often it passes into the chronic form.

Chronic subdeltoid bursitis begins in the acute form, or is of the same severity throughout. The pain is often annoying rather than unendurable. It may be quite intermittent, varying in severity. Often it is present only on certain motions (as in pulling on an overcoat sleeve, or attempting to comb the hair). Abduction may be limited to 45, 90 or 130 degrees; internal rotation may be much or little retarded. Passive movements are usually a little freer than active. External rotation is sometimes limited. In many cases the movements are perfect, but usually they are then more or less painful. Tenderness on pressure over the lesser tuberosity is usually present and often great. There may or may not be atrophy of the deltoideus and spinati.

This chronic form persists for months or years. Usually it subsides, with or without treatment, sometimes in spite of certain treatments. The lime deposit, if there is one, may gradually disappear completely.

The "chronic form with exacerbations" is of those cases, lasting for years, in which there is often a recession of symptoms, more or less complete, for long periods, but in which every few weeks or few months there is a severe exacerbation in which the symptoms approach those of the acute or even the "hyperacute" form.

TREATMENT

I am not inclined to place much confidence in electricity, baking, violet ray, internal medication or even massage. It is true, no doubt, that patients have recovered, by reason of such measures, or in spite of them. On the other hand, most of the patients referred to me have abandoned these treatments

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because their symptoms were unrelieved or even aggravated by them.

My first object, in the management of subdeltoid bursitis, is to overcome the abduction disability, the spasm (if there is any) and thereby, to a large extent, the pain. This I do by a simple automatic abduction method elsewhere described.[9] I put the patient to bed supported on several pillows and with his arm raised as far as he comfortably can abduct it. A towel or bandage sling is passed from the wrist or elbow to the head of the bed, and this end of the bed is raised on blocks or chairs (Fig. 8). It will often be noted that as soon as the patient is comfortably recumbent he can abduct his arm more than when standing. As he gradually slides down in bed his arm correspondingly goes up; and it is no rare experience in a patient who has not abducted his arm more than 45 degrees in many months to find it thus fully and painlessly abducted in twenty-four hours. Usually it takes a few days longer. If the patient cannot sleep with his arm in this sling, or cannot maintain that position continuously, he may intermit this gradual traction. Codein and acetyl-salicylic acid are helpful aids in overcoming the pain the first day or two. When passive abduction is thus fairly secured, active abduction is restored with it, and the pain soon disappears also in most cases. The abduction is maintained, and internal rotation is secured by after-treatment with Indian club exercises.

This plan of treatment is equally applicable to acute, "hyperacute," and chronic cases. It is of little or no value in chronic cases with no loss of motion. These cases, in which pain is the only symptom, are, in my experience, the most difficult to cure. Fortunately, the patients usually recover spontaneously.

I have come to the belief that most patients who have subdeltoid bursitis recover under this plan of

9. Brickner, W. M.: A Simple Easily Regulable Method of Applying Abduction in the Treatment of Shoulder Disability, Med. Rec., New York, Jan. 2, 1915.

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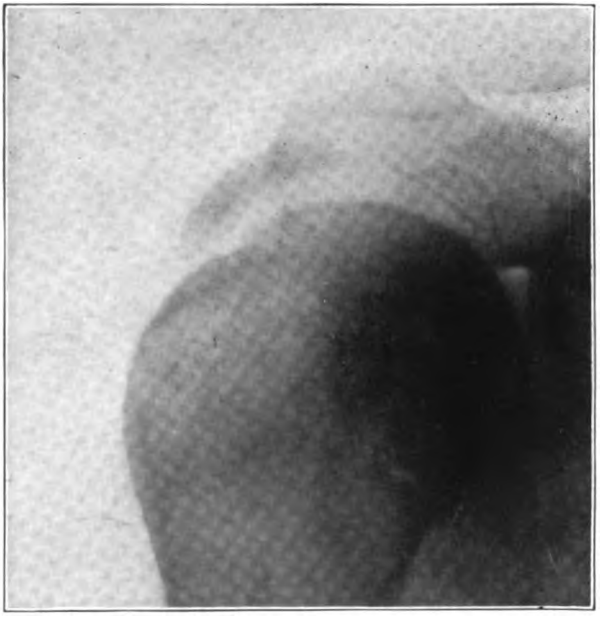

Fig. 1.—Large semifluid lime deposit beneath the bursa.

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Fig. 2.—Very small deposit near the supraspinatus insertion.

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Fig. 3.—Deposit in the supraspinatus tendon.

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Fig. 5.—Very large, dry, caplike deposit, only partly n the tendon.

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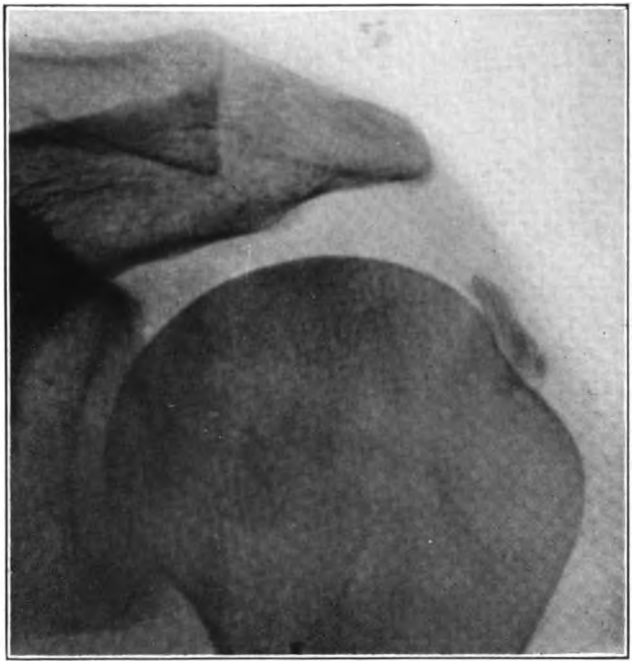

Fig. 4.—Deposit in the supraspintaus tendon.

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Fig. 5.—Very large, dry, caplike deposit, only partly n the tendon.

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Fig. 6.—Multiple deposits in the supraspinatus.

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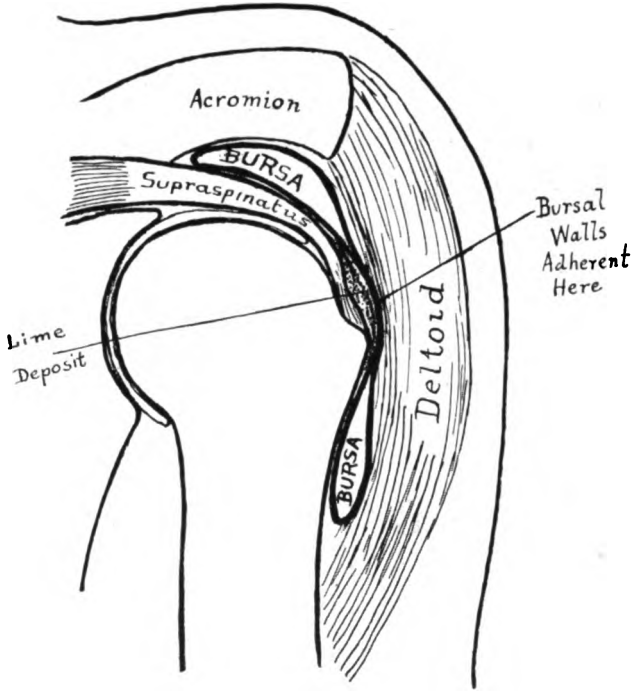

Fig. 7.—Diagram showing why many surgeons think they find the deposit in the brsa. Over the mass the two bursal walls are adherent and, unless separated by the operator, they are incised as one.

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Fig. 8.—Easily regulable method of automatically restoring abduction in the treatment of shoulder disability.

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treatment in bed with automatic abduction, or the trouble subsides spontaneously, though slowly. There are some, however, that do not thus recover and some that, though they may eventually do so, meanwhile suffer so much pain, loss of function and interference with occupation that operation is to be recommended as a means of prompt cure. I would therefore advise operation in the following cases: 1. In the chronic form with exacerbations. These patients have been through all sorts of treatment for years; their sufferings during the periods of exacerbation are severe; they show no tendency to spontaneous recovery. 2. In acute, "hyperacute" and chronic cases in which the automatic abduction in bed fails to restore function and to relieve pain and spasm.

The operation I employ I have previously described.[10] In consists in: splitting the deltoid; raising the outer wall of the bursa from the inner and incising it; dividing all adhesions in the bursa; incising and retracting the floor of the bursa; removing the deposit, if extratendinous, and suturing any tear in the supraspinatus tendon; or incising the tendon wherever indicated by the roentgenogram and excising the deposits with surrounding tendon fibers, and reuniting the tendon with chromicized catgut (if the defect is not too large); suturing the floor of the bursa with a fine running catgut stitch; anointing the interior of the bursa with a thin layer of petrolatum; suturing the outer wall of the bursa; suturing in layers, without drainage, the deltoid muscle, the deltoid fascia and the skin; abducting the arm in plaster of Paris for about a week.

The petrolatum may not be important. The reconstruction of the bursal walls is not essential, but it aims at an anatomic operation. The abducted position is also not essential, but I believe that it shortens the after-treatment, which consists in Indian club exer-

10. Brickner, W. M.: Footnote 3, first reference.

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cises and other devices to restore internal rotation and full abduction.

All the patients thus operated on have been promptly relieved of pain and early restored to full activity. In only one patient, a physician, was there any complication — a brachial phlebitis which retarded his recovery a few weeks.

In one case of chronic bursitis without any lime deposit, in which the pain and disability continued, with exacerbations, for years, division of the adhesions and abduction for one week were followed by permanent cure. This is the only case without lime deposit in which I have operated. It illustrates, first, that the roentgenogram of a deposit is not essential to a diagnosis of subdeltoid bursitis and, second, that division of the adhesions (and placing petrolatum in the bursa) will effect a cure when conservative measures fail, even in the absence of the lime mass.

30 West Ninety-Second Street.

ABSTRACT OF DISCUSSION

Dr. Eli Moschcowitz, New York: [Dr. Moschowitz demonstrated lantern slides made from specimens of portions of supraspinatus tendons submitted by Dr. Brickner for pathologic examination.] The lesion is a tendonitis, characterized by necrosis or hyaline degeneration of the tendon with secondary calcification, and a reactive granulation tissue around these areas of necrosis or calcification. The morphologic changes parallel the duration of the disease; thus, in long standing cases abundant scar tissue is present, while in early cases the granulation tissue is richly cellular. I believe that the necrosis was due to actual death of tendon tissue and was not of hemorrhagic origin because blood pigment was entirely absent. The necrosis is, in all probability, due to cutting off of the meager blood supply of the tendon consequent on the trauma. Calcification inevitably follows in those portions of the tendon that have undergone necrosis or hyaline degeneration. This is the usual consequence in other tissues of the human frame. The remarkable feature is the early incidence of the calcification. We are accustomed to think of calcification as occurring only after the tissue has been dead for some time, but in the cases that Dr. Brickner reports calcification occurs as early as forty-eight hours after the onset of symptoms. The only possible explanation of this early calcifica-

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tion is found in the results of the experiments of Litten and Schujeninoff, who found lime twenty-four hours after traumatic necrosis of the kidney and muscle, respectively. Perhaps the peculiar predilection to early calcification may be due to certain biochemical products in the tendon itself (collagen?).

Dr. J. Bion Bogart, Brooklyn: I want to say a word from the standpoint of one who suffered for four and a half years and has not been cured. Four and a half years ago I had a surgical infection through the index finger which resulted in metastatic infection of the shoulder joint and which was opened and drained and afterward had extension for four weeks. I was able to work after that, though I still have limitation of motion in the joint, but not ankylosis. My chief symptom, in addition to limitation of motion, is pain, which is not present except on motion or pressure. One of the most serious difficulties that I labor under is inability to turn on my left side to sleep at night. I cannot lie on that shoulder because the pressure causes too much pain. When I raise my arm it causes pain, which runs down the arm.

In my own case, so far as I know, there was no injury. I think that the same infection that caused the metastasis to the shoulder joint produced the bursitis, which was not, however, recognized at the time. Following recovery from the early symptoms, I had treatment with baking and massage for two months, after which I gave it up, because I did not gain anything in motion and the treatments were followed by pain. This kind of treatment did not seem to do me any good, but harm, if anything. I have done nothing since for the last four years. I was roentgen rayed at the time of my infection, and since then, a year and a half ago. The gentleman who did it later, Dr. Wasch, is here. There was no calcareous deposit then, and, so far as I know, there is none now.

Now what is it that causes my pain? I have none when the arm is at rest, but only on pressure or motion. If adhesions cause it in the cases in which there are no deposits, I think they are sure to be reformed after operation; and I do not see how relief can come from the operation in such cases as mine. I do not see, either, how relief could come from forcible stretching of the arm upward. It cannot be done immediately, but only gradually; but, as the scapula moves with the arm, I do not see how benefit could come in that way.

Dr. Fred J. Fassett, Seattle: Have any of those present seen the very rapid disappearance of these lime deposits? I have seen one case, reported by Dr. Risley of Boston, and also one of my own, in which the disappearance of the calcification was so rapid as to cause a question as to the authenticity of the plates.

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Dr. Milton G. Wasch, Brooklyn: I have been fortunate enough to have made roentgenograms in a great many of these cases. Within the last six months I have seen twenty-five. It has always been my custom to make roentgenograms of the opposite shoulder for comparative study, and I have been surprised, in a good many cases, to find lime salts in the opposite shoulder, in which the patient had not complained of any symptoms either at that time or previously. I, therefore, feel that the statement that deposits of lime salts form in one or two days is doubtful. I think when the patient complains of symptoms due to subacromial bursitis the probability is in most cases that the calcium has already been deposited and that the condition and suffering are from an acute exacerbation of a chronic calcifying bursitis.

Dr. Willis C. Campbell, Memphis, Tenn.: I should like to emphasize a point that Dr. Brickner made in his paper, that mild trauma is the frequent cause of this condition; and also that this injury may be overshadowed when other parts are seriously damaged. I had such a case in a young man. The injury was received in an automobile accident and he did not recognize the trouble in his shoulder for six weeks. By that time there was beginning atrophy. I did not see him for six months after the accident; then there was extreme atrophy and considerable trophic disturbance in the arm with abduction totally limited. Relief was soon given by simple abduction in a plaster cast, followed by massage, etc.

Dr. Heinrich Wolf, New York: I have had occasion to treat a few hundred cases of subacromial bursitis and should like to know what stand Dr. Brickner takes now regarding the infectious origin of some of these cases. We know that a great many are traumatic.

With particular reference to the remarks of the last speaker, I would say that I have noticed a great many cases following Colles' fracture of the wrist. If a patient falls on his hand and gets a fracture of his wrist, the pain in his wrist is so severe that he neglects a probable slight injury in the shoulder joint. I have seen about twenty cases of this in the dispensary of the Mount Sinai Hospital, in which subacromial bursitis developed five or six weeks after the injury to the wrist.

Then I have seen patients get a similar condition after infectious conditions in the hands. I cannot explain in what way an infection in the hand can be followed by subacromial bursitis, but I have seen it too often to consider it an accident. I hope that Dr. Brickner will be able to answer this question, particularly about the infectious condition. I have seen lately quite a number of cases of acute bursitis in which I was positively able to trace it to infection in the teeth. I know that Dr. Brickner does not believe that this is possible; but I mean, of course, only a certain number of cases. I want

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to say that I have seen other etiologic factors, but that in these particular cases removal of the teeth relieved the pain.

Dr. John Dunlop, Washington, D. C.: In some cases with a lime deposit in which operation was performed I found absolutely no adhesion. I should like to ask Dr. Brickner whether he considers that all cases of lime deposit have subacromial bursitis. I think in most cases they are quite separate conditions.

I believe there is nothing in Dr. Brickner's exposition, other than what Dr. Codman brought out in his paper in 1908. I have seen four cases of such deposits, in one of which operation was performed. In the first three cases that I saw operation was refused. I put the arm up in the abducted position and the patients got as well as any other cases of subacromial bursitis that I have seen. The fourth case was in a man who had so much pain that half a grain of morphin every four hours would not quiet him. I tried to put his arm up in the abducted position under nitrous oxid anesthesia. This increased the pain so markedly, however, that I operated. Dr. Brickner showed that he found adhesions. I found no adhesions in this case. I cut down to the bursa and demonstrated it to be as large, as Dr. Codman explained, as the palm of the hand. I saw the white mass shining through the base of the bursa and cut down on this and was able to scoop it out with a spoon. It was of the consistence of a soft toothpaste and quite white. I sent it to the laboratory of the Army Medical School and hoped to get a report on it from there; but it was lost. I did, however, get a negative bacteriologic report. I passed a probe well up within the sheath of the supraspinatus muscle and was sure that I was within it. The lower and upper surfaces of the bursa were closed and the man got a perfect functional result.

The day after I heard Dr. Brickner read his paper I had a case in an officer in the Marine Corps who refused operation. I put his arm up in abduction and he got well. Later, he had symptoms in the other shoulder, of which I had not made roentgenograms when I operated on the first shoulder. I treated that, and he got so well that he now plays tennis and golf every day. He still has the deposit in the shoulder, eighteen months after the diagnosis was made.

I do not agree with Dr. Brickner that these deposits occur within a few hours. We have no evidence that they do, for we do not take roentgenograms of our patients before. I think the symptoms come on from some trauma due to the deposit which may have been there for weeks, months or years before. It seems to me, from my four cases, in three of which there was no operation, that these patients will get well without operation.

Dr. Walter M. Brickner, New York: Dr. Dunlop reports that he found a lime deposit in the tendon in a case in which there were no adhesions in the bursa. That does occur. I

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referred to it in an earlier paper as "calcareous tendinitis without bursitis." I do not wish to claim anything that belongs to Codman, who was the first to suggest, in three cases, that the deposit is under the bursa. He speaks of it, however, as wenlike and cystlike, which it is not; and the conception of it as being often wholly within the tendon was not brought forth by Codman.

Concerning the rapid formation of the deposit, you are right in questioning my statement. The deposit may have been there before the symptoms called for a roentgenogram, but I have, not only once, but several times, found patients who, two days after a fall on the shoulder, or a lurch of the body while hanging to a car strap, showed this deposit in the picture, patients who never previously had any symptoms, but who had the characteristic symptoms after the injury. In one such case, "hyperacute," I operated a few days after the injury. The deposit had been shown by the Roentgen ray three days after the injury. I found a fresh tear in the ecchymosed supraspinatus tendon, and the lime deposit in the tear and in the surrounding bruised tendon tissue. Whether I am right in the assumption of very rapid lime formation, I am willing to leave open. I have not seen rapid disappearance of the deposit. I have seen it occur within two to six months, but not earlier.

I believe that I have fully answered Dr. Wolf's question. Occasionally one encounters metastatic suppuration in the bursa in connection with a septic process; but I believe that the cases of subdeltoid bursitis of which we have been speaking are not infectious in origin. Sometimes a man reports an isolated case in which the patient had tonsillitis previously, and then be jumps to the conclusion that the tonsillitis was the cause of the disease. That is unscientific.

I hope that I have made it clear that these patients often get well without operation.

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SIMPLIFIED TECHNIC IN LAMINECTOMY

WITH DESCRIPTION OF COMBINED LAMINECTOMY AND SPINE FIXATION BY BONE TRANSPLANT

F. J. GAENSLEN, M.D.
MILWAUKEE, WIS.

The operation of laminectomy has become so well standardized that one feels a certain hesitancy in presenting modifications. However, the technic that I have employed during the past few years has been found rather simpler than that of methods previously described, so that a description of it appears warranted.

Briefly, the essential point lies in the fact that instead of stripping the soft parts and the periosteum from the posterior vertebral spines on either side and then cutting off the spines at their bases, the spines are split longitudinally into right and left halves, just as in the Albee operation for insertion of a bone transplant in Pott's disease. However, instead of deflecting the halves on one side only, as in the Albee technic, the split halves are deflected on both sides. It is then a very simple matter to separate the periosteum with attached soft parts from the laminae as far laterally as the articular processes. The posterior spines should be split well down to their bases. There is then left only a small remnant of the process to be cut away with bone cutting forceps. The cutting away of the laminae can be accomplished by any one of the numerous methods advised.

Details of Technic.—The first steps are like those in the Albee spine fixation. A curved incision is made slightly to one side of the row of posterior spinous processes through the skin and subcutaneous tissue.

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The flap is rapidly reflected, exposing the deep fascia on either side of the middle line. With a stout knife, a straight incision is made down the middle line, splitting the supraspinous ligament and incising or at least marking the tips of the spinous processes themselves. A tenotomy knife is now used to dip down between the individual spinous processes, dividing the interspinous ligaments. With a very thin chisel the spines are now split through the line indicated, care being taken to keep as close to the middle line as possible. On reaching the base of the spinous processes, the chisel is driven slightly to one side, and the corresponding halves are broken and deflected to that side. With a gauze sponge over a periosteal elevator, the periosteum is now stripped from the corresponding laminae to the articular processes. This is easily and quickly accomplished without injury or fraying of the periosteum with the clean start obtained, as just indicated. It is the ease and rapidity with which this can be done, and the relatively slight hemorrhage encountered as compared with other methods, which particularly recommends this procedure. With a few strokes of the chisel the opposite standing halves of the posterior spines are now broken off close to their bases, and deflected to the side, the periosteum being stripped back as on the opposite side. The next step consists in biting off with suitable forceps the remaining portion of the bases of the spinous processes and cutting through the laminae by any one of a number of suitable methods. The Hudson drill and a number of rongeur forceps of suitable size and shape will answer the purpose very well. After removal of the laminae, the spinal contents are dealt with as circumstances demand.

The closure of the wound is in no way complicated by the method of approach outlined. In fact, the clean cut wound edges showing the split halves of the spinous processes and the split supraspinous and interspinous ligaments offer good opportunity for accurate approxi-

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mation. When the split spines are not too thick a stout, full-curved cutting needle can be passed directly through the corresponding halves, holding them in firm apposition. This is not necessary, however, as they will be held sufficiently firmly by sutures taken through the periosteum or the dense ligamentous tissue above and

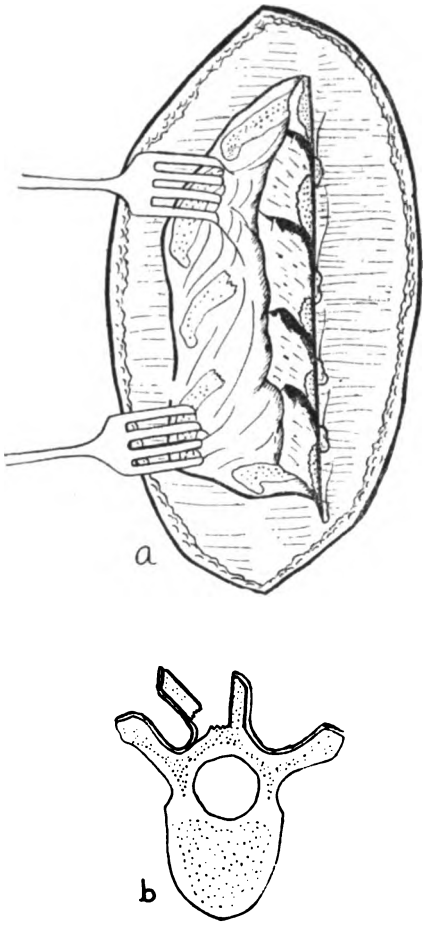

Fig. 1.—Posterior spinous processes (*a*) split in the middle; the left halves are deflected with the periosteum leaving the denuded laminae on that side exposed; the right halves remain standing; *b*, cross section, showing splitting of posterior spinous process and denudation of lamina on left.

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below. A few intermediate sutures serve to unite the interspinous ligaments. The preservation of the spinous processes, so far as they have been split, though

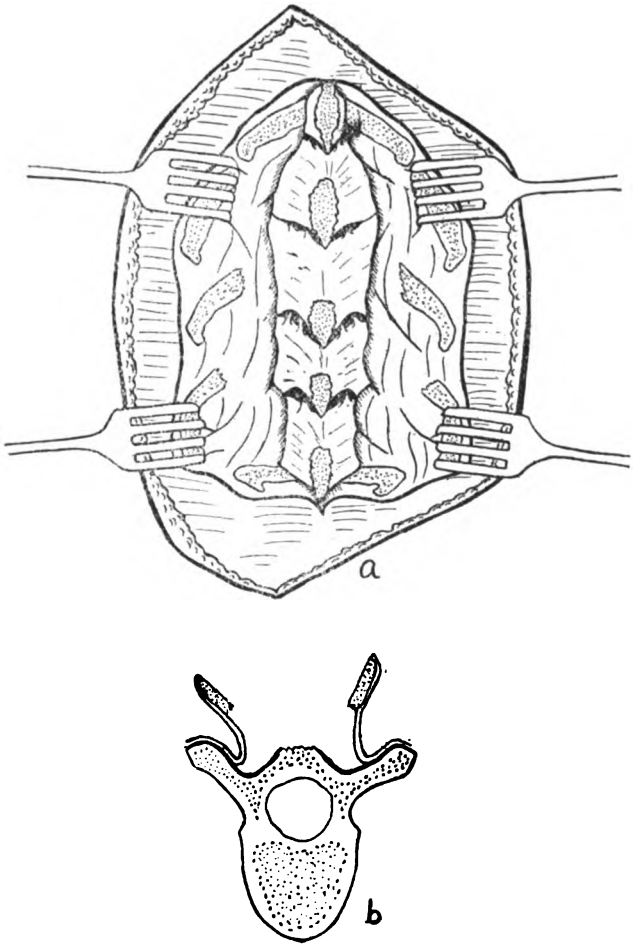

Fig. 2.—Broken spinous processes (*a*) deflected on both sides, exposing denuded laminae on both right and left; *b*, cross section.

by no means an essential to firm union, may be regarded as a distinct advantage in securing greater firmness and accuracy in closure.

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In one instance, when a laminectomy was done for fracture of the fifth cervical vertebra, death occurred some six weeks after operation from ascending kidney infection and trophic ulcers. The laminectomy wound had healed perfectly and the split halves of the spinous processes were firmly adherent to one another, though with a little force they could be separated with a snap, showing that bony union was well under way.

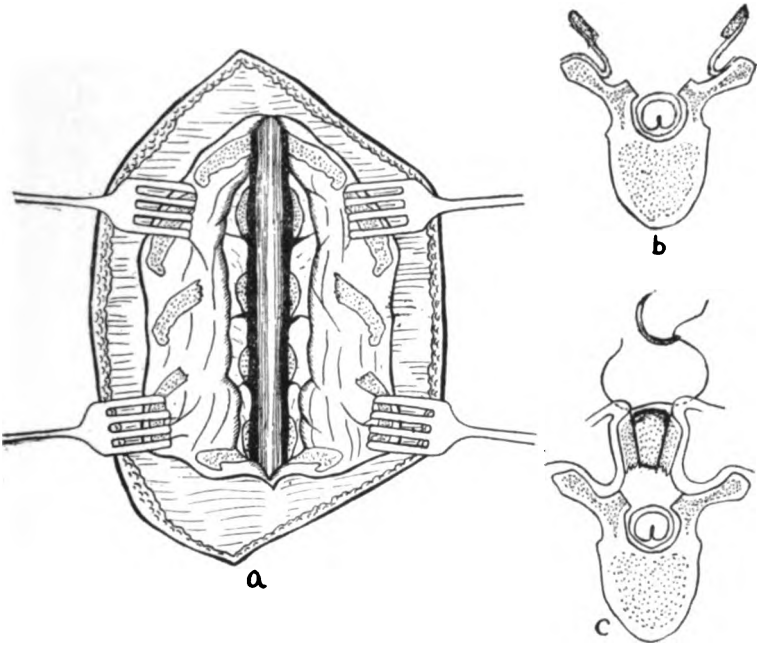

Fig. 3.—Laminae removed (*a*); cord exposed; *b*, cross section; *c*, cross section of vertebra in laminectomized area showing bone graft in place and suture introduced.

The advantages of the method of approach, outlined above, are: (1) rapidily; (2) diminished trauma; (3) diminished hemorrhage, and (4) more accurate and firmer closure, by virtue of the union of the bony components.

In certain instances, after laminectomy for urgent cord pressure symptoms, it may be desirable to fix the

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spine by means of a tibial transplant immediately after decompression of the cord. After the usual operation practiced heretofore, in which the spinous processes are sacrificed, a bridging over of the laminectomized area by means of a tibial graft would be a hazardous proceeding, the graft receiving bony contact only above and below the laminectomized region. This hazard would naturally increase with the length of the laminectomized area. It may be regarded as a universally accepted fact that a bone graft has far better chances of becoming firmly united, if it is in contact with numerous healthy bone surfaces. The method of approach, indicated above, by preserving the spinous processes and therefore retaining the usual number of bony contact points, paves the way for a successful combination of laminectomy and spine fixation by means of the bone graft. This plan was carried out in two cases, in both of which a diagnosis of vertebral tuberculosis had been made with urgent cord symptoms. After decompression of the cord, by laminectomy, performed according to the plan just outlined, several healthy spines above and below were split after the usual manner. The left halves were deflected while the right halves remained standing. A graft of sufficient length was then cut and put in place, bridging over the laminectomized area and finding anchorage above and below on the standing halves.

In both instances, primary union was obtained. In the first case, one with a middorsal lesion, the spine is held perfectly rigid, the graft fulfilling its mechanical function perfectly. In the second, a case of cervical Pott's disease with urgent symptoms, death occurred about four weeks after operation from an ascending urinary infection.

To be sure, indications calling for the employment of this combination of procedures will be encountered only rarely. Traction and recumbency in the hands of most orthopedic surgeons will prove adequate in the vast majority of cases, but in certain cases of Pott's

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disease, possibly also in some cases of fracture of the spine, a combination of the two will be found desirable. The experience in the cases just reported would indicate also that the method is feasible.

141 Wisconsin Street.

ABSTRACT OF DISCUSSION

Dr. Edwin W. Ryerson, Chicago: My experience with this operation is confined to one case, which I had recently, for fracture-dislocation of the spine. The procedure of Dr. Gaenslen was not exactly followed, in that I used a motor saw to split the spinous process, thereby causing less traumatism than when the chisel and mallet are used. The operation was nearly bloodless, much less hemorrhage being encountered than when the spinous processes are exposed and cut away by the rongeur. This procedure is the more valuable, as it gives an opportunity to put in a bone splint in cases of pressure on the spine caused by tuberculosis. These cases do not often require laminectomy; but when they do, one would hesitate to do a simple decompressive laminectomy, if there were no possibility of fixing the spine afterwards; but with one of the tibial splints, we may properly hesitate less to do it than in the past.

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JUXTA-ARTICULAR BONE LESIONS OF THE HIP

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AND
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NEW YORK

The beginner in bone surgery is apt to think of the diagnosis of disease of the hip joint as a simple matter, but longer experience will convince him of his error. As pointed out by Gibney in 1884,[1] the diseases of the hip are many, owing to different infections and pathologic processes, and may be located in the joint, in the bone adjacent to it, or in the soft parts. Many affections which were formerly classed as hip disease or tuberculosis of the hip, especially since the wide use of the roentgen ray in diagnosis, have come to be recognized as distinct conditions. Such conditions, now classed as separate affections, are coxa vara and slipped epiphysis, lesions fairly well known and not difficult to diagnose. More recently, osteochondritis of the hip, Perthes' disease, or quiet hip disease (Taylor[2]), a perfectly benign affection, has been studied and separated from tuberculosis of the hip. While studying Perthes' disease, characterized by its mild symptoms and course, our attention was called from time to time to lesions in the neck of the femur or in the trochanteric region, benign in character and causing mild symptoms extending over a considerable period. These cases, usually brought to

1. Gibney, V. P.: The Hip and Its Diseases, Birmingham, New York, and London, 1884.
2. Taylor, H. L., and Frieder, W.: Quiet Hip Disease, Surg., Gynec. and Obst., February, 1916.

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the surgeon on account of a persistent lameness with little pain or stiffness, could not be distinguished clinically from early osteochondritis; but the roentgen ray revealed instead of a flat and irregular epiphysis, a perfectly normal head and epiphysis with a spot of osteolysis (light spot) in the neck or trochanteric region.

These cases are often due to the process known as hemorrhagic osteomyelitis (Barrie[3]), which never results in pus formation. In another class of cases, localized infectious foci with pus formation are found, the so-called "bone abscess," which may result from the acute invasion of any pus-forming organism, or may arise from the lighting up of a local process in an old osteomyelitis. Several examples of roentgenographic bone spots, both of infectious and of noninfectious origin, will be given in this paper. Similar processes may occur about the acetabulum, but these will not be considered here, nor will malignant or benign neoplasms, tuberculous and syphilitic disease, or other rarer conditions which may produce local bone lesions in the neck and trochanteric regions.

It is well to know that lesions of soft parts adjacent to the hip, such as abscess of the soft parts, bursitis, and hematoma, may affect the function of the hip joint without affecting the bone, or even the synovial membrane. Acute and transitory conditions simulating an acute synovitis may result from strain or mild infections and pass away after a few weeks, leaving no impairment; but our discussion will be confined to the two classes of local bone lesions mentioned above, when occurring near the hip. They also occur near the knee and ankle and in the upper extremity, and may rarely be multiple; it is hoped to describe these conditions in later papers.

The one common symptom of the various hip conditions, at least when somewhat advanced, is lameness,

3. Barrie, George: Cancellous Bone Lesions, Ann. Surg., February, 1915.

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and when a child suffering with lameness of longer or shorter duration is brought to the physician he should never rest satisfied until a positive diagnosis is made, no matter how mild the symptoms. This means that, besides a thorough clinical examination, the roentgen ray should be used in every doubtful case. Repeatedly we have seen, in cases of mild lameness with few or no other symptoms, the diagnosis established at once by the presence of a light spot on the roentgen plate.

Certain light spots are due to focal osteolysis caused by hemorrhagic osteomyelitis (Barrie). The process may exist without causing any symptoms, as in a case (Case 3) recently observed, in which a roentgenogram of the hips was made, simply because the boy had a spot in the lower end of the opposite femur. In several of these cases, the lesion was of large size and in an advanced stage, though the lameness had lasted only a few weeks. In many instances there is a history of a near or remote fall or injury. Usually the lesion is as large as a dime or a nickel before the advice of a bone surgeon is sought. By this time there is a little wasting of the thigh and leg muscles, and a little pain about the hip or knee. As the lesion becomes larger, the lameness and pain increase, the activity of the child is diminished, and his condition is not quite up to par, though often the general health is entirely unaffected; there is no fever. In a few cases there are sudden exacerbations with severe pain and inability to walk. The process may go on until the entire area at the base of the neck and the trochanter is involved, leaving only a cortex of egg shell thinness.

In two of our patients (Cases 8 and 9), the femur broke on slight violence, in both instances healing kindly under splinting. These cases are usually called tuberculosis of the hip and treated as such (overtreated), even by experienced diagnosticians; they are occasionally called sarcoma.

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Among our cases there are several with spontaneous healing, with fibrosis or ossification and complete restoration of function, under general or symptomatic treatment and regulation of activity, and sometimes without treatment. In other cases, the cavity becomes larger with or without expansion of the bone cortex, and sometimes perforation occurs. A piece of the wall may come away as a flake, but there is no real sequestrum, no involucrum, and no pus formation. In these advancing cases evacuation of the focus with moderate curettage of the cavity, and in the larger ones the introduction of autogenous bone chips, give uniformly good results. The cavity becomes obliterated and usually reossified. When the cavity is opened it is found filled with reddish or grayish granulations, much like spleen pulp, or by a yellowish or grayish mass like custard, or by mottled fibrous material, or again by a straw-colored serum. The cavity may or may not have trabeculae or a lining membrane; it is sometimes multilocular. The mild curettage and the introduction of bone chips stimulate osteogenesis, and the result is usually perfect or nearly perfect restitution of structure and function.

General hygienic management and a reasonable curtailment of activity, and short periods of splinting and recumbency when indicated, are effective in the milder cases without operation. The lesion and lameness may last for several years.

THE PATHOLOGIC PICTURE IN HEMORRHAGIC OSTEOMYELITIS (BARRIE)

In about 75 per cent. of our series of bone lesions termed hemorrhagic osteomyelitis, a definite history of initial trauma or injury has been obtained. These injuries, not necessarily severe, produce numerous minute fractures of some of the delicate bone trabeculae that compose a great part of the osseous structure. In turn, there follows a disturbance of the normal anatomic circulatory apparatus. As the venous

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supply is here composed of vessels that are without any muscular coat, the lack of support of trabecular framework causes dilatation of the lumen of the vessels, varicosities, venous stasis, and rupture with effusion. The size of the initial lesion, through solution of continuity, may now be increased by pressure from within, exerted against the very delicate normal surrounding osseous structure, causing inhibition of nutrition, rarefaction and further destruction of the bone trabeculae, with repetition of circulatory disturbance noted above.

Efforts at regeneration and restoration are brought about in the formation of highly vascular granulation tissue. As no virulent or infective process is here involved, the injury being due apparently to mechanical insult to tissues that are sterile, and as there is no great massive destruction of structure, the inflammatory process is of a mild type.

It is a well known fact that a low grade inflammation producing granulation tissue always causes proliferation beyond its given need. In these bone lesions it is found that, when the bony defect is filled, several changes take place.

1. If the chemotactic properties in the blood of the individual cause a sufficient stimulant reaction, the vascular granulations are converted into final osseous structure, and full anatomic restoration and architectural arrangement of tissues result.

2. The host may possess the power to produce a metaplasia in the lesion by converting the granulation tissue that fills the bony defect into fibrous structure only. In this event the further progress of the lesion is stayed. It is Nature's effort at cure. While the stimulant reaction of the blood is not enough to give normal restoration of structure, it marks the end of any further progress in the lesion. The fibrous metaplasia causes contraction and retraction of the former exuberant vascular granulations. This stage

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of the process gives a picture of a fibrocystic osteomyelitis. Absorption or disappearance of all connective tissue apparently sometimes occurs, leaving a bone cavity without any lining membrane, but with bony walls rather more dense than the adjoining outlying tissue. Such a cavity may contain sanguineous fluid only or, what is perhaps more frequently observed, a thin straw-colored fluid. The fluid is sterile, and pus is never present.

3. If conditions pertaining to the host are hostile to either of the foregoing reactions, we observe little or no change in the granulation tissue occupying the bony defect. The attempts at regeneration are feeble, apart from the proliferation of granulation tissue. A vicious circle is thus established. Overproduction of granulations causes pressure on the osseous structure that it is apparently unable to withstand. Nutritional inhibition of the framework produces rarefaction and further bone destruction, followed by circulatory disturbances and changes. This stage of the lesion, when it attains any size, is quite commonly wrongly termed, clinically and roentgenologically, "giant cell sarcoma." The histopathologic picture presented in this stage of the lesion is marked particularly by the presence of numerous multinucleated giant cells that are apparently performing their scavenger function of removal of débris. They are practically never present in the second phase of the lesion.

BONE ABSCESS

An infective bone spot may result from acute pneumococcus, staphylococcus, or other acute infection, when the invasion may be sudden, with fever, pain and constitutional symptoms. The symptoms are much more severe and the disability greater than in the noninfective bone lesions. The acute stage may pass over into a chronic stage, when the symptoms are moderate, more like those of a beginning hip tubercu-

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losis, for which it is usually mistaken. Some cases begin without any acute symptoms and generally acquire a slight lameness which may persist for a considerable time, and cannot be distinguished clinically from either hemorrhagic osteomyelitis or beginning Perthes' disease. The roentgenogram will help, but is not always decisive as between a benign bone spot and a bone abscess. If the cavity at operation is filled with pus, which, however, may be sterile, the lesion is a bone abscess.

One of our patients (Case 13) was treated for several years for hip tuberculosis, when the bone abscess finally discharged itself in the trochanteric region, with later ossification of the spot and complete restoration of function. These lesions, when extrinsic and virulent enough, cause hip joint symptoms by secondary infection or through extra-articular soreness.

In another class of cases, an old osteomyelitis of the upper end of the femoral shaft or the trochanteric region may, after years of quiescence, light up into a local focus, showing a light spot on the plate (Cases 17 and 18). This is because bone once infected may become quiescent, but probably carries infective organisms ever after. They may light up locally after trauma or impaired nutrition, or without any visible cause, not becoming infected throughout but only causing one or more local bone abscesses.

The invariable treatment is to open the bone and evacuate, scrape out and disinfect the abscess. Pus is always found. The cavity should be wiped out with tincture of iodin, drained, and allowed to granulate from the bottom. Such cases do not always heal at once, but many heal in a short time, and most of them do so after a few weeks or months, while the pain and disability are quickly relieved.

Similar treatment is also suitable for tuberculosis confined to the trochanter or base of the neck, and such timely measures will often prevent an extension of the process to the joint.

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COMMENTS ON ROENTGENOGRAPHIC APPEARANCES (BARRIE)

The roentgen-ray diagnosis of hemorrhagic osteomyelitis is not, as a rule, difficult to make. The plate shows a light spot with smooth outlines and no sclerosis; it may appear to be reticulated or multilocular. It is, however, frequently impossible to state positively, even with the combined clinical and roentgen-ray pictures, the exact stage which the lesion presents, that is, whether it retains its primitive form of a highly vascular granulation tissue mass (solid type so-called giant-cell sarcoma); whether the lesion is fibrocystic in character (metaplastic stage), or whether the contents of the localized area of osteolysis or bone disintegration are wholly fluid (so-called bone cyst) Our experience does not coincide with that of some roentgenologists, who state that they are able to differentiate between the roentgen-ray appearance of the solid and fluid lesions by the presence of trabecular division or septa. We have found identical roentgen-ray shadows in all stages of this lesion.

The roentgenographic picture in bone, exhibited by tuberculosis, syphilis, the acute infections, and benign and malignant neoplasms may readily be differentiated from the type lesions coming under the classification "chronic hemorrhagic osteomyelitis."

A conclusive and positive diagnosis regarding the exact type and stage of the lesion may be made only during operative interference. The light spot on the plate due to a bone abscess may be of irregular outline, may contain a sequestrum, or may be surrounded by sclerosed bone, but roentgenologically it is sometimes difficult to differentiate between a hemorrhagic osteomyelitis and a circumscribed medullary bone abscess that does not contain any sequestrum. The pus in such lesions is usually sterile.

Most of the cases on which the preceding study is founded were observed in the remarkably interesting

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MENTS ON ROENTGENOGRAPHY

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material which has been at our disposal at the Hospital for Ruptured and Crippled, New York. Abstracts of the histories follow. In all, the descriptions of the lesions are founded on roentgen-ray plates.

CASES OF HEMORRHAGIC OSTEOMYELITIS OF NECK AND TROCHANTERIC REGION [4]

CASE 1.—A girl, aged 7, Jan. 28, 1917, had a heart shaped light spot 1¼ by 2 inches in the left trochanteric region. Her health was good but she had stigmata of previous rickets. The patient slipped, four weeks before; this accident was followed by lameness and pain in hip and knee. At present all hip motions are painless and free; she has a moderate limp, and also slight atrophy.

CASE 2.—A boy, aged 3, Sept. 24, 1914, had a light spot the size of a robin's egg in the left trochanteric region. There had been no injury; twelve days before he had moderate pain in the knee and could not walk. The pain was soon relieved by plaster-of-Paris spicas, which he wore eighteen months.

CASE 3.—A boy, aged 7, April 24, 1917, had a light spot in the left trochanteric region the size of a robin's egg; there were no symptoms. The hip was examined with the roentgeon ray for information on account of pain, swelling, and lameness in the right knee, beginning three years before. The patient was treated for tuberculosis of the right knee at Neponsit Hospital, and wore plaster-of-Paris splints one and a half years. At present the knee function is perfect; there is no limp and no pain. A roentgenogram of the knee shows an extensive light area from changes due probably to hemorrhagic osteomyelitis. This is the first case of multiple lesions of this character observed.

CASE 4.—A boy, aged 17, Sept. 14, 1905, had a light spot the size of a lima bean in the region of the left trochanter minor. He had been slightly lame for over a year; he had mild hip-joint symptoms, and was put on crutches and high sole, and hygienic management. A month later a roentgenogram showed an oval light spot the size of a dime near the lower trochanter; the bone of the neck was much thickened.

Feb. 22, 1906, the spot was increasing. The patient was running down, and the hip motions were somewhat limited. The patient was put under ether and the small cavity that was filled with granulations was scraped out. The patient has recovered perfect function of the leg and has remained entirely well.

CASE 5.—A girl, aged 7, Nov. 11, 1916, Dr. Whitman's case, had a multilocular light spot occupying the whole of the right

4. Cases 7, 8, 9 and 10 correspond to Cases 11, 12, 13 and 14 in Barrie's[8] paper, "Cancellous Bone Lesions," which gives histories and illustrations.

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neck, as revealed by a roentgenogram. The symptoms had existed two weeks.

CASE 6.—A boy, aged 11, July 12, 1914, had a light spot in the neck of the right femur. He had been hit by a horse one year before. He had pain in the right hip for six months, which was worse at night; he had limped for two months. A diagnosis of arthritis of the right hip was made.

Oct. 9, 1914, motion of hip was limited; the boy had worn spicas until two weeks before; there was no spasm; roentgenoscopy revealed a spot in the neck the size of a large pea.

March 8, 1915, the focus was curetted by Dr. Barrie. The patient had continued to wear a spica and to get worse. The pathologic report was extreme acute osteitis.

April 11, 1917, the patient was well, with excellent function and no limp. Roentgenoscopy was negative for spot.

CASE 7.—A girl, aged 8, October, 1913, had a light spot in the left neck and in the trochanteric region. The patient fell, bruising the left hip, six months before; she had had pain in the left hip and had limped for the last three months; there were night cries for two months; there was slight atrophy and limitation of motion. Clinical diagnosis was acetabular tuberculosis of the hip. A roentgenogram revealed a light area the size of a pigeon's egg occupying the base of the neck and trochanteric region to the cortex. The Wassermann test was negative. A plaster spica was applied in June, 1914, with increase in the size of the lesion and of stiffness at the joint. Operation was performed by Barrie, July, 1914.

Exposure exhibited a hemorrhagic fibrocystic loose edematous mass easily removed and separated with the curet. There was free bleeding from the cavity walls, which had no lining membrane. The naked eye appearance of the lesion was that of the transitional stage of localized hemorrhagic osteomyelitis, in which the solid mass was undergoing fibrocystic changes.

Microscopic examination made from material curetted away revealed a variable histologic appearance. The bone trabeculae exhibited a slight degree of disorganization and the medullary tissue evidence of fibrosis. The principal feature appeared to be the presence of new-formed tissue composed for the most part of medium-sized fibroblastic cells. Here and there a multilobulated nucleus and a rare mitotic figure were seen. A few giant cells of the scavenger foreign body type were observed about the areas of disintegration, together with moderate hemorrhage, scattered foci of pigmented cells, and round cells.

In May, 1917, recent roentgenograms had shown reossification of the cavity. Three months before, the patient walked perfectly and was free from disability of any kind.

CASE 8.—A boy, aged 6, March, 1914, had large light area in the left neck and trochanteric region, as shown by roent-

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genogram. He had fallen down stairs a year before, bruising the left hip; he limped four weeks; there was no pain; there was tenderness over the trochanter, with slight limitation of motion. Wassermann and von Pirquet tests were negative. A plaster spica was applied. Several weeks later the patient was brought to the hospital unable to walk after a fall. Roentgenoscopy revealed a pathologic fracture through the light area.

June, 1914, operation, by V. P. Gibney, revealed a cavity without lining membrane filled with straw-colored fluid. A plate taken several months later showed union of fracture, filling in of cavity, and considerable reossification.

Case 9.—A girl, aged 4, May 29, 1914, had a large, light spot in the trochanteric and adjacent regions, as shown by roentgenogram. Eighteen months before, the patient fell out of bed. Four weeks before, the child began to limp; there were no joint symptoms, and measurements were equal, but there was tenderness over trochanter.

Three days later the child tripped and fell and was brought at once to the hospital unable to move the leg. A roentgenogram revealed a fracture below the trochanter through the pathologic area.

Case 10.—A girl, aged 18, Feb. 28, 1911 (patient of Dr. William Frieder), had multiple light spots in the right trochanteric region, which was enlarged. Six years before the mass had been curetted out, and a pathologic diagnosis of giant-cell sarcoma was made. Several Wassermann tests were negative. This patient was recently seen, ten years or more after the operation. She was in good health and walked well.

BONE ABSCESS CASES

Case 11.—A girl, aged 2, Feb. 15, 1915, had large focus a. the base of the right neck, with sequestrum, the size of a pea. Limp had been noticed six months before; her general condition was poor; the right leg was one-quarter inch shorter than the left; there was slight limitation of hip motion. The Wassermann test was negative.

Case 12.—A girl, aged 9, April 8, 1916, had a small focus at the middle neck of the left femur. Five years before she had had osteomyelitis of the right tibia with four operations. She had had pain in the knee the last six months; lately there had been swelling in the left adductor region; there was considerable limitation of motion.

April 11, 1916, the neck of the femur was tunneled from below the trochanter by Barrie; sequestrum was removed; the abscess in the adductor region was incised.

Nov. 9, 1916, the sinus was closed, the patient walked easily, with a slight limp.

Case 13.—A girl, aged 6, Oct. 6, 1912, had a bone abscess in the right neck; she had had scarlet fever and pneumonia in

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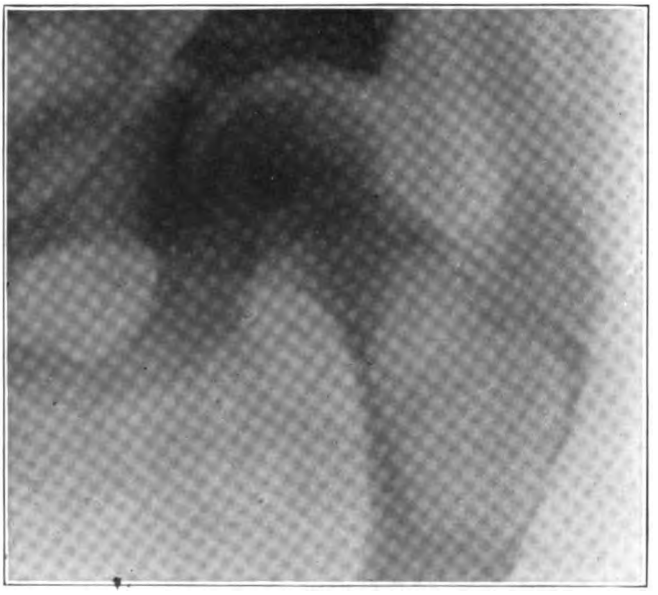

Fig. 1 (Case 1).—Hemorrhagic osteomyelitis in a girl, aged 7; there were mild symptoms for four weeks.

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Fig. 2 (Case 3).—Hemorrhagic osteomyelitis in a boy, aged 7; there were no symptoms.

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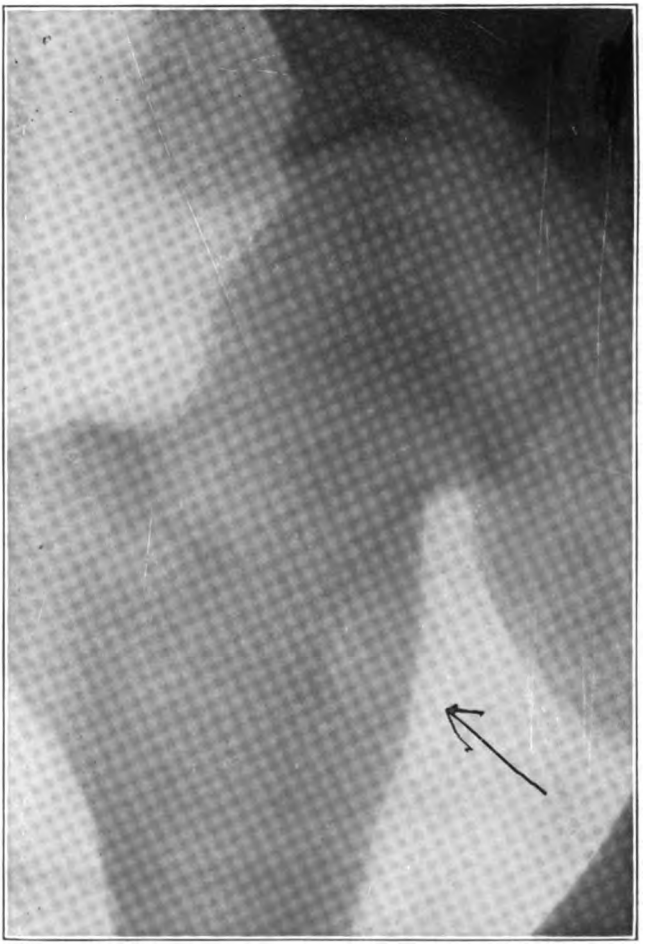

Fig. 3 (Case 4).—Hemorrhagic osteomyelitis in a boy, aged 17; there were mild symptoms for one year.

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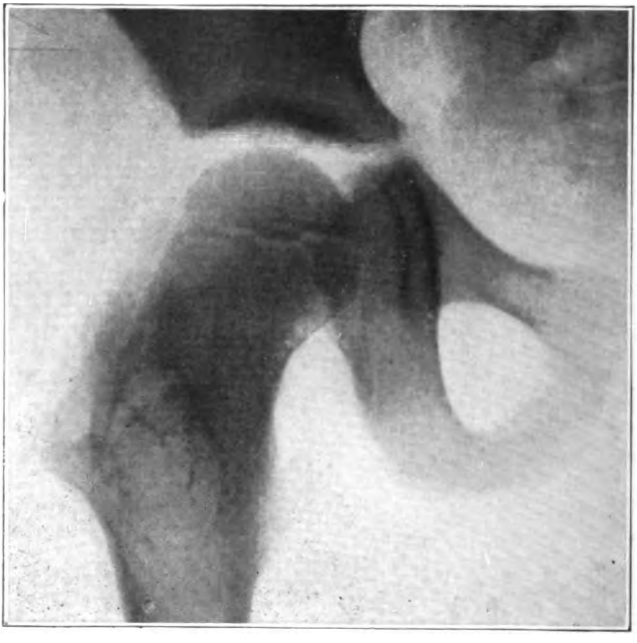

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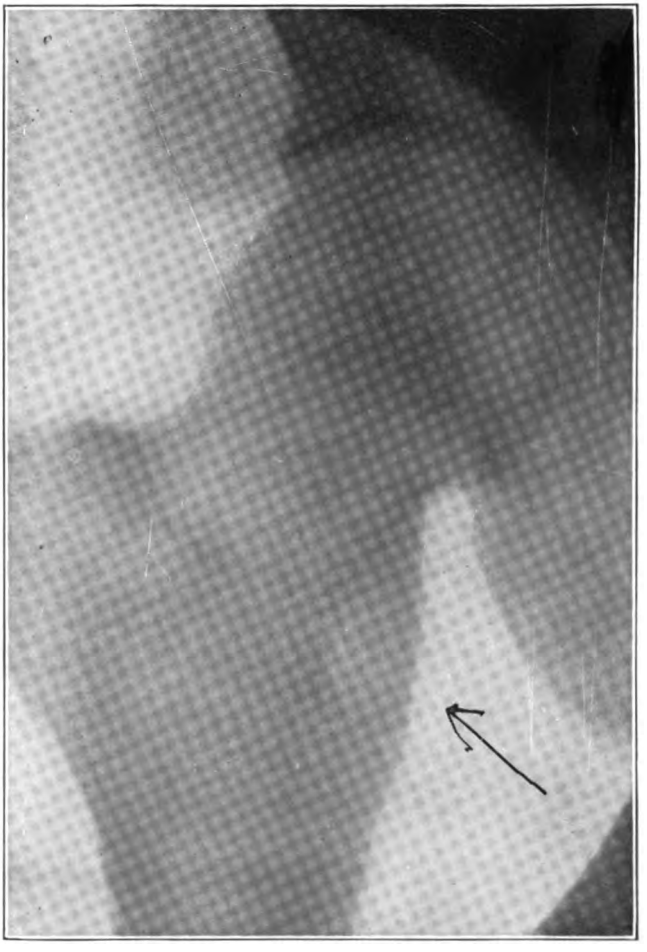

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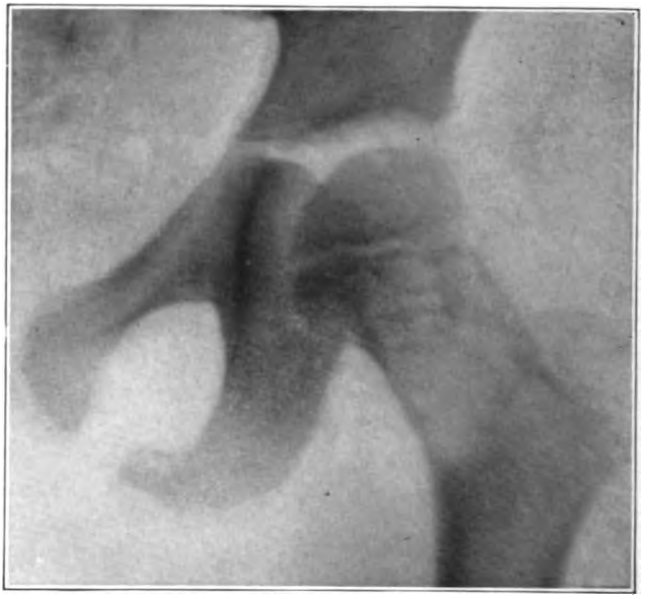

Fig. 4 (Case 5).—Hemorrhagic osteomyelitis in a girl, aged 7; there were symptoms for two weeks.

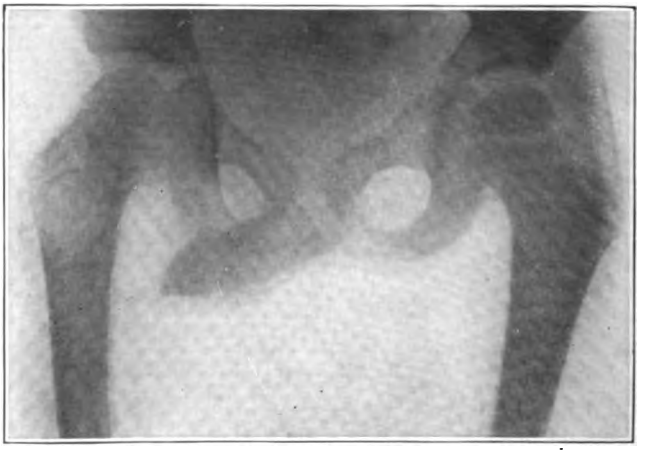

Fig. 5 (Case 8).—Hemorrhagic osteomyelitis in a boy, aged 6; he limped for four weeks. The roentgenogram was taken soon after the fracture though the pathologic area.

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Fig. 6 (Case 12).—Bone abscess, secondary to chronic osteomyelitis of tibia of opposite side, in a girl, aged 9.

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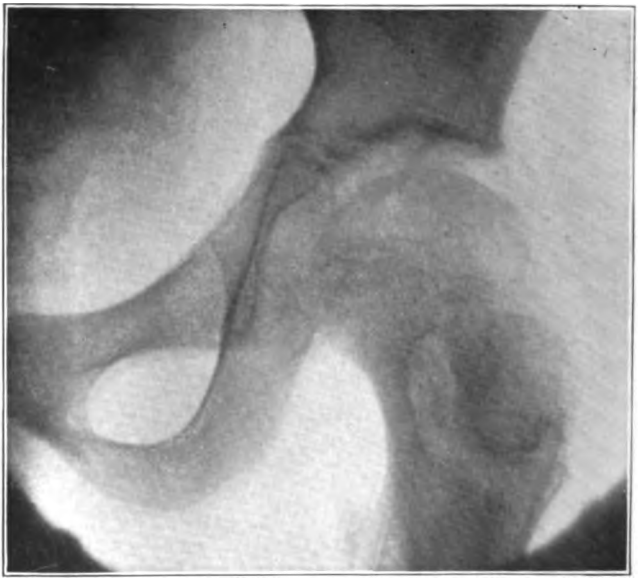

Fig. 7 (Case 13).—Bone abscess in a girl, aged 9; there were symptoms for three years.

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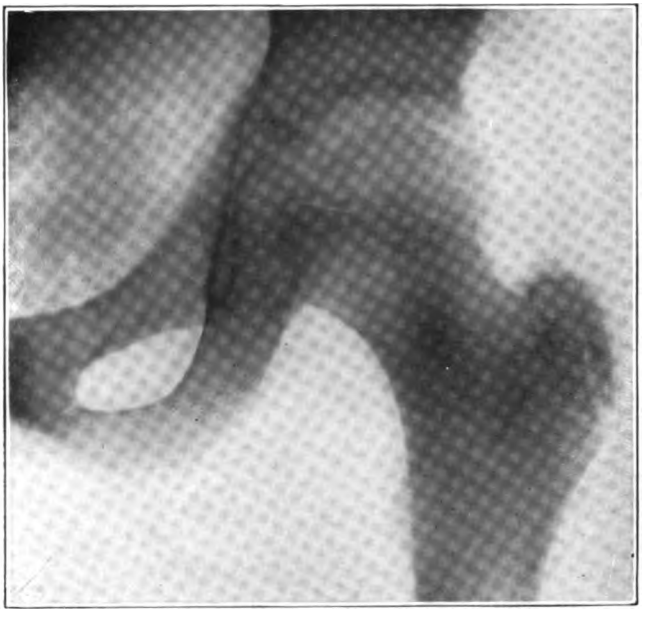

Fig. 8 (Case 13).—Roentgenogram taken one year and eight months later; there was a cure after spontaneous discharge of the abscess.

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Fig. 9 (Case 16).—Bone abscess in a girl, aged 18; there were symptoms for a few weeks, but she had had abscess twelve years ago.

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1910; her general condition was poor; there had been discomfort in the knee and night cries for two months. A diagnosis was made of tuberculous hip. She wore spicas for three years. An abscess several inches below the trochanter was opened in July, 1914; closed in December, 1916. A roentgenogram revealed a large light spot in the neck.

March 1, 1917, walking had been without limp or complaint for twenty months; her general condition was good; her legs were equal, hip motion was normal; roentgenograms were now negative for the spot.

Case 14.—A girl, aged 14 months, Oct. 26, 1911, had a bone abscess of the right neck; there were atrophy and pain in the right leg. The first diagnosis was poliomyelitis with history of attack four months before.

May 1, 1912, the child had night cries and was losing flesh; rotation was limited; the diagnosis was changed to tuber culosis of the hip. Soon after the roentgenogram showed large spot in the neck and atrophy of head. The diagnosis was again changed to bone abscess.

March 5, 1913, the child was plump and rosy; she had almost full hip motion; she still walked lame, with no pain.

May, 1917, the patient had been in a home for convalescent cripples for two years.

Case 15.—A boy, aged 9, Aug. 11, 1915, had a bone abscess of the left hip. He had pain in walking and at night. The attack came on suddenly four months before. There was some limitation of motion at the left hip. Roentgenoscopy was negative. The diagnosis was tuberculosis of the hip, and a plaster spica was applied.

Oct. 22, 1915, the thigh was flexed and adducted; two weeks before, the pain suddenly became severe and the patient could not walk; the hip was painful on motion; he was admitted to the hospital; the pain was relieved by traction in bed. A roentgenogram revealed a spot in the inferior lip of the neck, apparently containing a sequestrum.

Feb. 7, 1916, the patient was readmitted for pain and night cries; the abscess had appeared below Poupart's ligament and was incised.

July 14, 1916, the patient was free from pain, and was discharged in fair condition; a short spica was supplied and crutches were used.

Case 16.—A girl, aged 18, Jan. 29, 1916, had a bone abscess of the neck of the left femur. Twelve years before she had an abscess back of the trochanter, which healed in six months; she had had no further trouble until recently; she had had pain in the left thigh, knee and hip. She had no pain or stiffness on moving the hip. A roentgenogram revealed a light spot the size of a dime near the trochanter. Operation was advised and declined. The pain got worse and was considerably relieved by fixation in a spica.

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CASE 17.—A man, aged 23, Oct. 9, 1916, had chronic osteomyelitis of the upper end of the right femur, with bone abscess near the trochanter. Pain in the right hip and groin to the toes came on slowly five years before; the patient could not get off his chair for five weeks; he did not feel sick; since then he had had similar but milder attacks lasting about a week, every two or three months. Two years before, a sinus appeared 4 inches below the trochanter, which was still discharging. Two weeks before an abscess appeared below the trochanter. The patient's health is good; he is not lame, has no pain, with hip movements free. A roentgenogram shows a spot near the base of the trochanter.

October 18, curettement of the focus was performed by Taylor. The pathologic report was chronic inflammation and fibrosis.

CASE 18.—A man, aged 34, Dec. 4, 1916, had chronic osteomyelitis of the upper third of the right femur, with bone abscess. The patient had osteomyelitis of the upper third of the right femur at the age of 9 years, resulting in several sinuses, which did not entirely heal until eight years later. He was in bed one year at the beginning of the attack. He had been well and free from pain for seventeen years, until a month ago, when he had a dull pain in the upper part of the thigh, growing worse. There is acute tenderness at the outer and posterior aspect of the shaft of the femur below the trochanter and some induration. The leg is in good position with about 10 degrees of motion at the hip. The affected leg is a quarter inch longer than the other. A roentgenogram shows an area of bone induration, with a light spot the size of a pea in the middle.

Dec. 20, 1916, curettement of the focus was performed by Taylor.

March 1, 1917, the pain was relieved at once; the wound healed and the patient walked well.

SUMMARY

Local bone osteolysis may cause a light spot in the neck or trochanteric region on the roentgen plate. This may be due (*a*) to hemorrhagic osteomyelitis, which is a benign process usually running a chronic course with mild symptoms, notably lameness, and frequently ending in recovery, sometimes with and sometimes without an operation. Pus is never present; or (*b*) to a bone abscess with the formation of pus, which may run an insidious course with mild symptoms, or a more acute course with severer symp-

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toms, and if evacuated and drained, usually ends in recovery with good function.

Both classes of cases are often diagnosed as hip tuberculosis, and sometimes as sarcoma. An early correct diagnosis enables the surgeon to simplify the treatment and save the adjacent joint by a timely operation, when its integrity is threatened.

125 West Fifty-Eighth Street—24 East Forty-Eighth Street.

ABSTRACT OF DISCUSSION

Dr. E. D. Oppenheimer, New York: I should like to know which of the patients with these local lesions had also lesions in other bones; also what is the relation between this disease and the general metaplastic osteitis described by von Recklinghausen. Does the pathologic picture resemble that of the other disease?

Dr. Arthur Steindler, Iowa City, Iowa: My understanding is that it is now being recognized that osteitis deformans and the osteitis fibrosa of von Recklinghausen are not entirely different diseases. The osteitis deformans (Paget) is a generalized form of the other. From the roentgenogram I had the impression that the cysts had developed on the basis of an old osteitis fibrosa. They had a hemorrhagic content. I should like to know the differential point between that form and the cases that we diagnose as the osteitis fibrosa of von Recklinghausen.

Dr. Henry Ling Taylor, New York: I would call attento the importance of distinguishing infective and noninfective bone spots near the hip from hip tuberculosis, and to their more favorable prognosis under proper management. Dr. Barrie will answer the pathologic question.

Dr. George Barrie, New York: The lesions of hemorrhagic osteomyelitis are single lesions; that is, they have been single in the cases observed, numbering about forty. Three fourths of our patients have given a history of initial trauma. I think probably 75 per cent. of the lesions that start as a hemorrhagic osteomyelitis later result in a so-called bone cyst. The remainder retain their primary pathologic picture of hemorrhagic osteomyelitis, which is frequently termed medullary giant-cell sarcoma. I think they are not sarcomas, because we know that the giant cells found in the mass are not tumor cells. Further, I have been able experimentally to produce the lesion simulating so-called medullary giant-cell sarcoma.

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THE AGE AND SEASONAL INCIDENCE AND COMMUNICABILITY OF ACUTE POLIOMYELITIS

AS SHOWN IN THE EPIDEMIC IN NEW YORK CITY IN 1916

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NEW YORK

The epidemic of acute poliomyelitis which raged in New York City in 1916 was the largest on record. The statistics of the department of health are the most complete and accurate that we have. Previous epidemics were not only much smaller, but were studied by individual physicians or groups of physicians, in most cases after the epidemic had subsided. The records, therefore, were incomplete. By making the disease a reportable one from the beginning of the epidemic, the department succeeded in obtaining valuable data. It is true that a certain percentage of mild nonparalytic cases were not recognized and reported, but this percentage remained fairly constant throughout the epidemic, so that it does not interfere with the accuracy of the age and seasonal incidence of the disease, as based on the cases recognized and reported. Frost has drawn certain conclusions based on the study of three small epidemics. I shall endeavor to show how a study of the figures of the New York epidemic tend to verify some of his conclusions.

FREQUENCY OF THE DISEASE AS COMPARED WITH OTHER COMMUNICABLE DISEASES

In Chart 1, I have represented graphically the deaths from these diseases in New York City during the last five years. It will be seen that, as compared with

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pneumonia and pulmonary tuberculosis, the deaths from poliomyelitis are few; about twenty-six times as many are due to pneumonia and about twenty-two times as many to pulmonary tuberculosis. The number of deaths from tuberculous meningitis is important, because this disease also attacks young children almost exclusively (Chart 2), and the mortality is practically 100 per cent. As we know definitely the causative agent and the manner in which the disease is spread, it is to a great extent preventable; yet it has received no special attention. In the lower part of Chart 1, I have represented the number of cases of some of the other communicable diseases reported during the first nine months of 1916. Some of these diseases were less prevalent than usual, and still although the epidemic of poliomyelitis was the largest on record, the number of cases reported was less than that from measles, pulmonary tuberculosis or diphtheria.

AGE INCIDENCE

Chart 3 shows that poliomyelitis is distinctly a disease of early childhood. It seems highly probable that infants as well as young children are especially susceptible, for we have all observed cases in the first few weeks of life. The reason that the disease is comparatively uncommon in early infancy and most common between 2 and 3 years of age probably lies in the difference in the opportunity for coming in contact with the infectious material. Young infants are to a great extent isolated; after 2 years, children are able to run about and mingle freely with others. There is therefore a greater opportunity for infection. The greater susceptibility of young children is also shown by the fact that in cases of which I have notes, in 80 per cent. the patient was the youngest child in the family. This susceptibility of the central nervous system of infants and young children is also shown in the age incidence of tuberculous meningitis, Chart 2.

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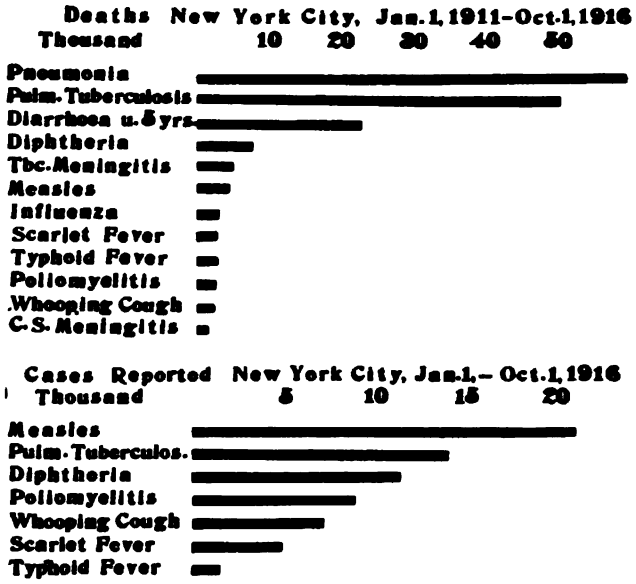

Chart 1.—Deaths, New York City, Jan. 1, 1911-Oct. 1, 1916; cases reported, Jan. 1-Oct. 1, 1916.

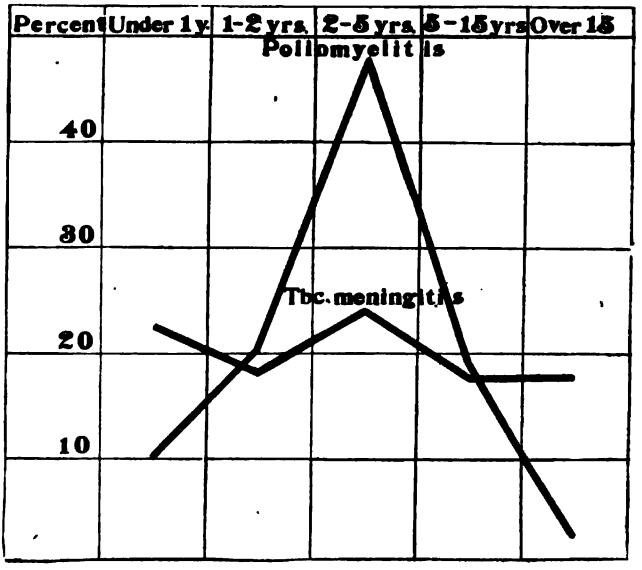

Chart 2.—Mortality from poliomyelitis and tuberculous meningitis.

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SEASONAL INCIDENCE

The epidemic in New York City occurred in late summer (Chart 4), as is the case in all temperate climates. In Scandinavia, however, epidemics have extended into the winter months. The high incidence in August and September is especially noteworthy, because at this time all the other communicable diseases are at their lowest point. Although meteorologic conditions may play a part in producing conditions favorable for the spread of poliomyelitis, contact infection is the controlling factor. In Chart 5, the course of the disease is shown in each borough. It will be seen that at one time the disease was on the rise in Manhattan, and Queens, while it was declining in Brooklyn, although of course the meteorologic conditions were the same in the three boroughs.

We have usually explained the increase of the communicable diseases at certain seasons by assuming that the climatic conditions were favorable for the growth of the infectious material. It is also possible, however, that we are more susceptible at certain times. It is well known that the growth of children is not uniform throughout the year. Even the increase in weight and height are not synchronous, but each has its season of most marked increase. Cushing and Goetsch ascribe hibernation in certain animals to a seasonal physiologic wave of pluriglandular activity. It may be that a period of pluriglandular inactivity may likewise render the individual more susceptible to infections of a certain type.

In Chart 4 it will be seen that in the epidemic of 1916, as in other epidemics, there was a rapid increase and a rapid decrease in the number of cases; the curve shows a sudden rise and fall. Such a course is found only in a disease which is very communicable, as measles, or in a disease in which carriers are numerous, and spread the disease rapidly. The curves of influenza (infectious epidemic catarrh) and lobar pneumonia show (Chart 6) a similar course, whereas the

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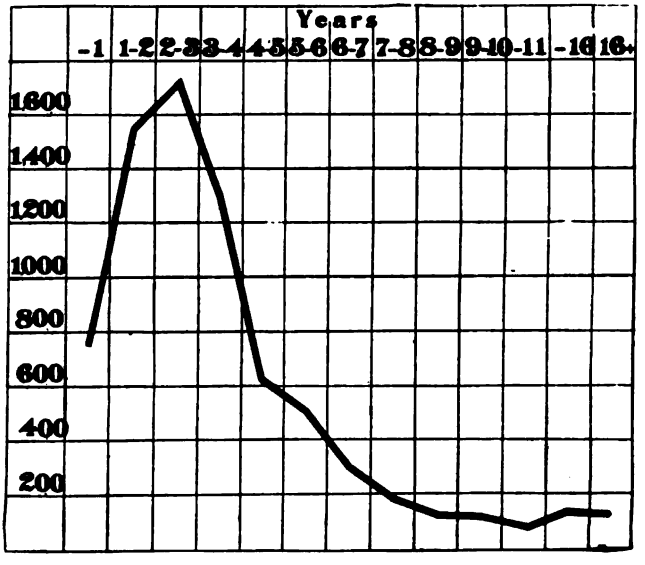

Chart 3.—Age incidence of poliomyelitis, New York City, 1916.

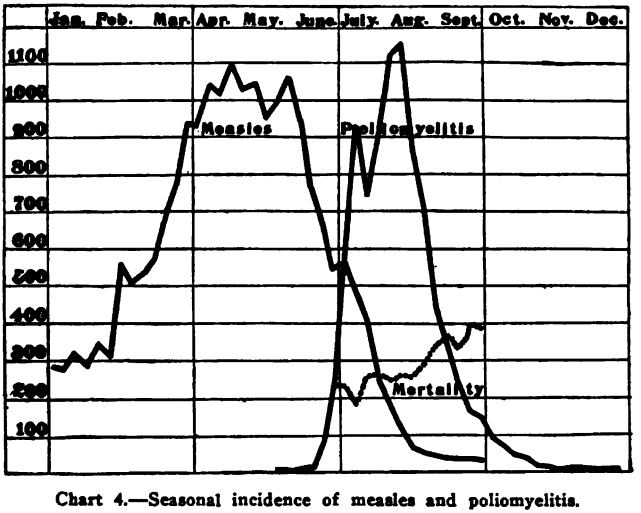

Chart 4.—Seasonal incidence of measles and poliomyelitis.

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curve of typhoid, in which carriers are comparatively few, is fairly uniform throughout.

The epidemic furnishes no evidence that any article of food, more especially milk, was responsible. Aside from the fact that the disease occurred in infants exclusively breast fed, only a contaminated food supply that was suddenly stopped could give such a curve; but it would not show progression from one borough to another. The evidence in favor of insects as an etiologic factor is still less convincing. One of the strongest arguments against this hypothesis is furnished by the age incidence of poliomyelitis (Chart 3). There is no reason why a disease which is spread by insects should attack only infants and young children. Yellow fever, typhus and malaria show no such marked predilection.

COMMUNICABILITY

The susceptibility of children to poliomyelitis is much less than to the other communicable diseases. I have investigated the conditions in 204 families which have come under my observation. Of these, 144 were being treated for various forms of paralysis, in the service of Dr. Kleinberg, in the orthopedic department of Lebanon Hospital. The remainder were seen in my hospital service and in private. In these 204 families there were 571 children under 13 years of age, an average of 2.8 children to each family, so that 367 were directly exposed to infection. Of these, seven, or about 2 per cent., contracted the disease. The reports of the Department of Health of the City of New York, show that 7,000 cases occurred in 6,748 families; that is, there were 252 secondary cases. The total number of children in these families is not stated; but if the figures from my own series of cases are used, 2.8 children to each family, there were 12,146 children exposed, and 252 contracted the disease, making a susceptibility of a little over 2 per cent. From

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figures compiled from cases which have come under my own observation, I have found that of children under 13 years of age, not protected by a previous attack, 96 per cent. contract measles when exposed;

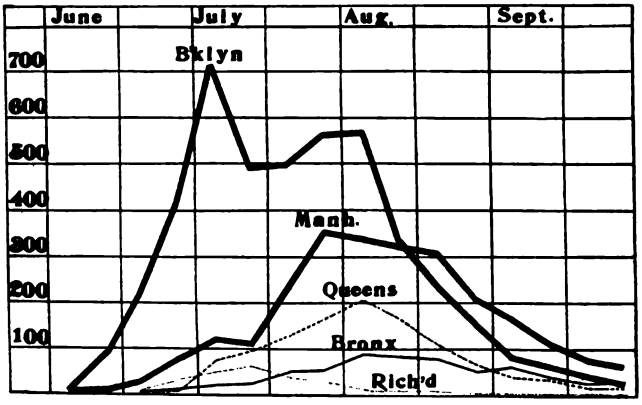

Chart 5.—Course of poliomyelitis in each borough of New York City, 1916.

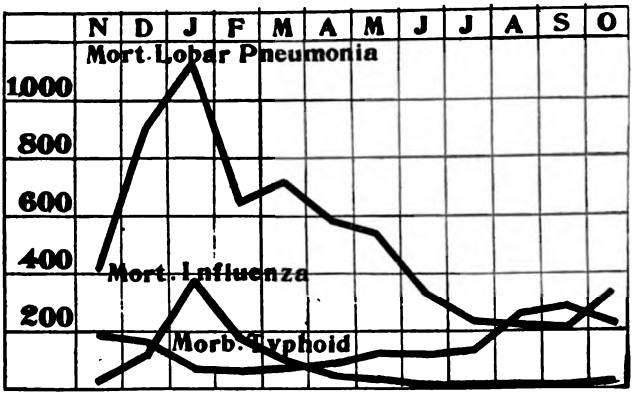

Chart 6.—Curves of lobar pneumonia, influenza and typhoid, New York City, 1916.

75 per cent. contract whooping cough (only undoubted cases are included); 25 per cent. contract scarlet fever, and 20 per cent. contract diphtheria.

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INDIVIDUAL SUSCEPTIBILITY

There must also be an individual susceptibility. In two instances I observed poliomyelitis in one of twins, the other remaining free (in one instance, two boys of 3 years; in the other, a boy and a girl of 2 years). In both, the two children were equally well developed, previously in good health, constantly together, taking the same food, and with the same environment; the two, therefore, were equally exposed. The only difference noted was that in the younger pair of twins, one year previous when they had an attack of measles, the boy had a moderate attack, the disease running a normal course, while the girl, who later developed poliomyelitis, had several severe convulsions in the course of the disease. This might have indicated or induced an increased vulnerability of the central nervous system.

Zingher[1] states that the Schick test is positive in nearly three times as many cases of poliomyelitis as in normal children, and that susceptibility to one of the less contagious diseases, like poliomyelitis, indicates that the child is more apt to be susceptible to other contagious and infectious diseases. Since in most cases infection takes place through the nasopharyngeal mucous membrane, this hypothesis seems plausible; however, it has not been borne out by an investigation of the 150 families in which there were two or more children, which have come under my own observation. In ten families the child with poliomyelitis had had diphtheria, and one or more of the other children in the family exposed had remained free, while in nine families another child in the family had had diphtheria, the child with poliomyelitis being exposed and remaining free. If the hypothesis should prove to be correct, we should have a simple and valuable means of detecting the susceptible children. I

1. Zingher, Abraham: The Schick Test in Poliomyelitis, Scarlet Fever, Measles and in Normal Children, Am. Jour. Dis. Child., March, 1917, p. 247.

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tested the Schick reaction on the two pair of twins already referred to. The boys both gave a positive reaction, the poliomyelitis patient a somewhat more marked reaction. In the other pair, the girl who had had poliomyelitis gave a negative reaction, the boy a positive reaction. It seems highly probable that the infection in poliomyelitis takes place through the nasopharyngeal mucous membrane. Amoss and Taylor

TABLE 1.—MORBIDITY IN THE EPIDEMICS OF 1907 AND 1916 IN NEW YORK CITY *

Borough	Population, 1916	Morbidity per 10,000	Under 5 Years, per 10,000	Percentage Over 9 Years	Morbidity per 10,000 in 1907
Manhattan....	2,634,223	9.5	6.43	7.69	1.61
Brooklyn.....	1,928,432	23.4	15.47	5.15	0.83
Bronx.....	575,877	10.9	6.78	5.39	....
Queens.....	366,426	30.6	16.64	7.62	....
Richmond.....	97,883	29.1	22.30	5.78	....

* Number of cases, 1916, 8,927; deaths, 2,343; death rate, 26.24 per cent.

TABLE 2.—PERCENTAGE OF AGE INCIDENCE

Ages	Percentage	
	1916	1907
Under 1 year.....	10.1	8.5
From 1 to 2 years.....	20.5	30.2
From 2 to 3 years.....	22.8	24.7
From 3 to 4 years.....	17.0	14.5
From 4 to 5 years.....	8.2	8.6
From 5 to 6 years.....	6.8	3.8
From 6 to 7 years.....	4.0	2.5
From 7 to 8 years.....	2.4	1.5
From 8 to 9 years.....	1.7	1.5
From 9 to 10 years.....	1.6	1.0
From 10 to 11 years.....	1.0	0.9
From 11 to 16 years.....	1.9	1.7
Over 16 years.....	1.7	1.0
Under 5 years.....	78.5	86.4

have shown that the secretions of these parts in most persons have the power of neutralizing or inactivating the virus of poliomyelitis. It is not unlikely that in some children this power is absent. Dr. Kleinberg, who has had large numbers of poliomyelitis patients under observation for many months has noted that they are particularly susceptible to nasopharyngeal infection.

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In communities in which poliomyelitis has already occurred, the number of persons infected is usually less. This is shown in the relative number of cases in the boroughs of Manhattan and Brooklyn in 1907 and in 1916. In 1907 the incidence per 10,000 population was 1.61 in Manhattan, and 0.83 in Brooklyn. In 1916 the proportion in Brooklyn was much larger, 23.5 per 10,000, as against 9.53 in Manhattan. As we should expect, the proportion of patients over 9 years of age, and therefore not immunized by exposure in 1907, was greater in Manhattan in 1916. In the recent epidemic in Manhattan, 7.69 per cent. were over 9 years, and in Brooklyn, 5.15 per cent.

TABLE 3.—SUSCEPTIBILITY

Number of Families		Number of Children Exposed	Infected	
			Number	Per Cent.
Personal observation.....	204	358	7	2
Department of health.....	6,748	12,146	252	2+
Measles.....	.....	.....	...	96
Whooping cough.....	.....	.....	...	75
Scarlet fever.....	.....	.....	...	25
Diphtheria.....	.....	.....	...	20

We shall probably not have a great epidemic of poliomyelitis in New York City in several years, because a large percentage of the susceptible children were attacked, or were immunized by exposure. A future epidemic will not be controlled by methods now at our disposal. It could, however, be controlled by a method of detecting the 2 per cent. of susceptible children, and immunizing these against the disease. Reasoning by analogy, the prophylactic use of convalescent serum would be more effective than its therapeutic use, and could be given in smaller quantities.

SUMMARY AND CONCLUSIONS

1. The epidemic of poliomyelitis which occurred in New York City in 1916 was the largest recorded. Nearly 9,000 cases were reported.

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2. The crippling resulting from poliomyelitis is less than from the other communicable diseases and heart disease. A child with a partially paralyzed limb is less handicapped in the struggle for existence and the enjoyment of life than one with defective hearing or a diseased heart.

3. The other communicable diseases of childhood are more common and cause more deaths.

4. Infants and young children are especially susceptible. Young infants are less frequently attacked, because less exposed to infection.

5. A large proportion of patients under 5 years of age does not indicate a mild epidemic.

6. The same increased susceptibility of the central nervous system is seen in the age incidence of tuberculous meningitis.

7. In temperate climates, epidemics occur during the summer months, but sporadic cases occur throughout the year. In Scandinavia, epidemics have extended into the winter months. Meteorologic conditions do not play the most important rôle in the spread of the disease. Seasonal changes in the power of the nasopharyngeal mucous membrane to neutralize or inactivate the virus of poliomyelitis may account for the increased susceptibility.

8. Patients who have had poliomyelitis seem to be more susceptible to the ordinary nasopharyngeal infections.

9. The susceptibility of children under 13 years of age to poliomyelitis is much less than to the other communicable diseases of childhood. It is present in only about 2 per cent. The susceptibility to measles is about fifty times as great, to whooping cough about thirty-five times, and to scarlet fever and to diphtheria about ten times.

10. Children who are susceptible to poliomyelitis are not necessarily more susceptible to the other communicable diseases.

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11. There exists a distinct individual predisposition or susceptibility.

12. We shall probably not have another great epidemic in New York City for several years, because a large percentage of the susceptible children have been attacked or have been immunized by exposure to the disease.

13. A future epidemic could be controlled if we had a method of detecting the 2 per cent. of susceptible children and could immunize these against the disease with convalescent serum.

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RESULTS OF THE RECENT EPIDEMIC OF POLIOMYELITIS IN NEW YORK STATE

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ALBANY, N. Y.

The wave of poliomyelitis which swept over the United States last summer helped to clear up some obscure and disputed points in its epidemiology. From the standpoint of preventive medicine, a knowledge of the mode of contact, transmission and communicability is essential in order to control the spread of disease. The material on which this paper is based was obtained from a study of 4,186 cases reported to the New York State Department of Health from June to December, 1916. This does not include the cases occurring in the city of New York.

The age incidence in the state differed somewhat from that in the city, as 55 per cent. of the cases occurred in children under 5 years of age, as compared with 90 per cent. in New York City. Poliomyelitis was almost entirely a disease of childhood in the city of New York, where there were only 1.7 per cent. of the cases among persons over 16 years of age. In the state, exclusive of New York City, 10 per cent of the cases were of persons over 16 years of age. This difference between the age incidence in urban and rural sections of the state seems to be borne out by the experience of other states in the last epidemic. At the Cincinnati meeting of the American Public Health Association, Dr. Frost declared that "studies of statistics of such epidemics as are now available show that in rural epidemics, especially those in Iowa and

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Minnesota, a much larger proportion of the cases have been in the higher age groups than has been the case in epidemics occurring in large cities."

Dr. Frost suggests an explanation for this difference, when he says, "Certain other infectious diseases, notably measles, are largely limited to children, not because they are essentially children's diseases, but because the adult population has been more or less immunized." It seems not unlikely, therefore, that the limitation of poliomyelitis in urban epidemics almost entirely to children may be due to the fact that adults had developed a certain degree of immunity, through mild and perhaps unrecognized attacks in their early years; while the persons in more sparsely settled areas, who had been less exposed to the contagion of the disease in their childhood, had not acquired the degree of immunity which would render them able, as adults, to resist the infection when present in epidemic form.

The mortality among the 4,186 patients was 866, or 21.1, as compared with the mortality in the city of New York of 27.2. The age incidence in the mortality between the city and the state is similar to that in the morbidity. In New York City, 79 per cent. of the total deaths were of patients under 5 years of age, while in the up-state cities these deaths constituted 59 per cent., and in the rural sections 45 per cent. In the rural sections of the state, 19 per cent., or nearly one out of five deaths, occurred over the age of 16. The popular term "infantile paralysis" is therefore a misnomer.

The period of incubation as shown by a study of 756 cases to determine the date of paralysis after the first sign of acute symptoms was: 68.7 per cent. within three days; 79 per cent. within four days; 95.7 per cent. within seven days, and 98 per cent. within ten days. This would indicate that the period of incubation is comparatively short. It can therefore be stated

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with some degree of positiveness that the incubation period is from three to ten days. If a child who has been exposed to a patient with poliomyelitis does not develop symptoms of the disease within two weeks, it can be considered safe.

The most important point to determine and about which no reliable information has been published is the length of time a patient having poliomyelitis may transmit the disease and be a menace to the community.

PARTIAL PERIOD DURING WHICH PATIENTS WITH POLIOMYELITIS WERE A SOURCE OF INFECTION

Primary		Secondary		Date of Exposure	Onset	Partial Period Poliomyelitis Communicable in Primary Cases
Case No.	Onset	Age	Case No.			
1616	Aug. 1	18 mo.	448	Aug. 4	Aug. 21	8 days
571	Aug. 2	2 yr.	475	Aug. 3	Aug. 14	1 day
P-538	Aug. 23	12 yr.	538	Aug. 22	Aug. 28	1 day
P-538	Aug. 23	12 yr.	539	Aug. 22	Aug. 29	1 day
970	Aug. 5	16 yr.	551	Aug. 11	Aug. 15	6 days
2104	Aug. 30	9 yr.	635	Aug. 30	Sept. 5	1 day
2672	Sept. 1	5 yr.	673	Sept. 3	Sept. 9	2 days
1653	Aug. 6	3 yr.	687	Aug. 10	Aug. 20	4 days
3158	Sept. 18	19 mo.	709	Sept. 19	Sept. 28	1 day
2406	Aug. 26	4 yr.	1016	Aug. 26	Sept. 4	1 day
1005	Aug. 9	6 yr.	1084	Aug. 7	Aug. 17	2 days
1238	Aug. 1	10 yr.	1060	Aug. 8	Aug. 12	7 days
3588	Sept. 18	7 yr.	2055	Sept. 18	Sept. 27	1 day
3034	Sept. 12	7 yr.	3286	Sept. 14	Sept. 19	2 days
2188	Aug. 24	2 yr.	2354	Aug. 24	Aug. 31	1 day
1078	Aug. 11	2 yr.	2414	Aug. 13	Aug. 17	2 days
942	Aug. 11	4 yr.	1612	Aug. 10	Aug. 18	1 day
Robt.E.	Aug. 26	2 yr.	Irene S.	Sept. 3	Sept. 14	8 days

The data studied were obtained from reports sent to the department by physicians and sanitary supervisors. It was necessary to include in this study only those instances in which the date of onset of the primary case was positively established and a definite date when the secondary case was exposed. The number of cases in which these data were returned was necessarily small, as in most instances a strict quarantine was imposed as soon as the case was diagnosed, so that the number of exposures was limited.

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From the table of thirty-six primary and secondary cases, it would seem that the longest period a primary case was actually observed to be infectious was eight days, and in most cases it was one or two days. There were a number of cases reported in which the onset of the disease was reported one or two days after an exposure. Not all of these were included, as it was felt that in many instances they probably received their infection at the same time that infection occurred in the so-called primary case. The conclusion to be drawn from this study is that for the protection of public health a period of quarantine of three weeks would render ample and sufficient protection. This is the period required in the city of Washington and in the state of Wisconsin. A longer period is unnecessary and often a distinct hardship.

That poliomyelitis is transferred by contact is becoming more generally accepted. A committee appointed by the New York City Department of Health, headed by Dr. Simon Flexner, announced a few days ago its conviction that the disease was thus transmitted. A commission appointed by Surgeon-General Blue of the United States Public Health Service stated that "the infectious agent was transmitted chiefly by contact with patient or carrier, but exact incidence of such contact is often difficult to determine on account of unrecognized forms of the disease." This commission further observed that "this disease was widely prevalent and was most frequently of the nonparalytic type."

No one could fail to become convinced that the infection is transmitted by contact after studying the spot maps made of the cases as they were reported in the state from week to week. The cases followed the lines of communication with such consistency as to be unmistakable. One epidemic which has been carefully studied out by Mr. Chalmers, statistician of the department of health, was proved to have resulted from exposures at a county fair.

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CONCLUSION

We have learned from this recent pandemic that poliomyelitis is transmitted by contact with a patient or a carrier; that the period of incubation averages seven days, and that three weeks is a sufficient period to hold a patient with poliomyelitis in quarantine.

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FATIGUE AND EXERCISE IN THE TREATMENT OF INFANTILE PARALYSIS

A STUDY OF ONE THOUSAND EIGHT HUNDRED AND THIRTY-SIX CASES *

ROBERT W. LOVETT, M.D.
BOSTON

This analysis of 1,836 cases of infantile paralysis consists of a study of the records of the first round of the poliomyelitis clinics of the New York State Department of Health, which began, Oct. 17, 1916, and finished. Jan. 20, 1917.

The paper is an abstract of a preliminary report on the scientific side of the work, presented to the New York State commissioner of health, to whom I am indebted for permission to publish these data. Extensive tabulation has been made of many points in the report to the commissioner, with whom have been deposited all the original records from which these data are drawn. The presentation here of a large number of tables would be simply confusing and defeat the purpose which I have in mind, which is merely to call attention to four salient points which I believe these figures show. The tabulations were made to cover a large number of points, most of which proved to be of no great interest or importance; but certain of the tables told a perfectly definite story, and this paper will be devoted to the study of these points. They are that:

1. A complete examination in every case gives a different picture as to the general and special distribution of the paralysis from the usual one.

* Abstract of preliminary report made to the state commissioner of health of New York.

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2. Muscular weakening is much more frequent than total paralysis.

3. A greater severity of the degree of paralysis in the legs of old as contrasted with new cases suggests that the weight-bearing use of the legs in walking is harmful.

4. The differing functions of the right and left arms may be utilized for the study of the effect of nonweight-bearing exercise.

These cases were studied with great care in the clinics, and in every instance an examination was made by one of the three surgeons in charge, Dr. Armitage Whitman, Dr. John T. Hodgen or myself. In every case this examination included both arms, both legs, back, neck and abdomen. It consisted in obtaining, or attempting to obtain, voluntary contraction of each different muscle or muscle group, with limbs placed under favorable conditions of leverage. The muscles were then graded as:

1. Normal.
2. Good, when the muscle was strong enough to overcome gravity and some resistance, but was not quite of normal strength.
3. Fair, when the muscle was able to overcome gravity, and could perform part of the normal movement.
4. Poor, when slight movement could be accomplished but gravity could not be overcome.
5. Trace, when no movement of the limb could be accomplished, but the muscle could be felt to contract.
6. Totally paralyzed, when attempted voluntary movement was not accompanied by any perceptible contraction of the muscle.

According to this standard, every available muscle or muscle group was classified in every case. Any such classification is subject to a certain amount of personal variation, but this proved on the whole close enough to give a general idea of the character of the muscle. For purposes of simplicity in the paper, the muscle is spoken of as if it were the only structure to be considered; but it is recognized that in this study

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the muscle is to be considered as the index of the condition of the neuromuscular mechanism. In the 1,836 records taken consecutively from our files for analysis, 513 were of children 3 years of age or less. Such records, although carefully made, are not sufficiently accurate for detailed analysis on account of the age of the children, and were omitted from the study except where especially stated.

This leaves for detailed analysis 1,323 cases in which the patients were over 3 years old. These form two groups: (1) a group of 948 cases with onset in 1916, and (2) a group of 375 cases with onset in 1915 or earlier. The recent cases were from one to six months' duration when the patients were seen at the clinics, and the group of old cases had lasted from a little over a year to twenty-two years, with an average duration of over six years (Table 1).

The groups of recent cases and old cases were studied separately on all points, and the data of the two groups compared. In the recent cases we had patients just emerging from the acute stage with the original phenomena of the disease unmodified. In the group of old cases we had a picture of the disease years after the attack, with modifications induced by the conditions under which the patient had lived in the interval. Few had received continued modern treatment, all had been as active in walking as their disability had allowed, and these old cases represented what was liable to happen in the disease when treated by old methods, if treated at all, because patients under treatment by competent orthopedic surgeons were naturally not apt to appear at public state clinics. By contrasting, then, the phenomena of these two groups, it was hoped that something of the natural history of the disease might be learned.

Age.—The age tables show nothing of especial interest. Of 1,461 patients affected in 1916, 513 were under 3 years; 4.5 per cent. were over 20, two patients being over 50.

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GENERAL DISTRIBUTION

The tabulation of general distribution from this group of cases examined with great care shows that the distribution is not quite what certain earlier tabulations have shown it to be, and that certain locations

TABLE 1.—DURATION OF PARALYSIS AT EXAMINATION (THREE HUNDRED AND FIFTY-THREE OLD CASES)

Duration, Years	Number of Cases	Duration, Years	Number of Cases
From 1 to 2	25	From 12 to 13	7
From 2 to 3	28	From 13 to 14	3
From 3 to 4	38	From 14 to 15	5
From 4 to 5	29	From 15 to 16	2
From 5 to 6	38	From 16 to 17	2
From 6 to 7	62	From 17 to 18	3
From 7 to 8	41	From 18 to 19	0
From 8 to 9	20	From 19 to 20	0
From 9 to 10	32	From 20 to 21	0
From 10 to 11	9	From 21 to 22	2
From 11 to 12	7		

TABLE 2.—AGES OF PATIENTS

Ages, Years	Number of Cases	
	Affected in 1916	Prior to 1916
Under 1	65	..
From 1 to 2	224	..
From 2 to 3	224	2
From 3 to 4	195	15
From 4 to 5	135	21
From 5 to 6	125	14
From 6 to 7	97	23
From 7 to 8	63	36
From 8 to 9	56	37
From 9 to 10	40	26
From 10 to 11	48	46
From 11 to 12	27	28
From 12 to 13	18	21
From 13 to 14	15	17
From 14 to 15	12	18
From 15 to 19	54	40
From 20 to 29	46	25
From 30 to 39	13	4
From 40 to 49	2	2
50 and over	2	..
Total	1,461	375

of the paralysis are extremely common and practically important, as in the abdomen and neck.

In recent cases the most common involvement is of both legs, then one or the other leg, next in frequency all four extremities, then two legs and one arm, and

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after that one arm. Next in frequency comes a distribution of much importance—one arm and one leg—and here a hemiplegic arrangement is distinctly more common than one arm and one leg on opposite sides in both recent and old groups (Table 3).

The group of old cases shows the same general relative frequency as the recent cases, except in the involvement of all four extremities, two arms and one leg, and both arms, all of which are much less frequent than in recent cases. This shows the tendency of these extensive original paralyses to clear up in the arms. An important and serious type of paralysis which does not affect the extremities is decribed as the girdle type when the affection is chiefly of the back and abdomen.

TABLE 3.—GENERAL DISTRIBUTION IN THE ORDER OF RELATIVE FREQUENCY

	New Cases	Old Cases
Both legs	338	127
One leg	302	85
Both legs and both arms	127	55
Both legs and one arm	101	43
One arm	83	19
One arm and one leg, same side	38	18
One arm and one leg, opposite sides	29	7
Both arms	33	4
Both arms and one leg	20	8
Girdle cases	57	1
Facial alone	38	1
Total	1,166	363

Both sides of the cord are more frequently affected than one side. Of 705 recent cases, 60.5 per cent. affected both sides of the cord, as shown by the distribution of the paralysis on both sides of the body.

The frequency of paralysis of the abdomen, the back and the neck, as shown by this table, is so important as to require separate consideration.

Abdomen.—In 948 patients over 3 years of age affected in 1916, 72 per cent. were paralyzed in the abdomen, and these unique findings are undoubtedly because examination in every case was made as to this point. In my experience at least, many cases pre-

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viously have escaped observation because this especial point was not noted unless extreme. The normal child can sit up from the lying position with the arms crossed on the chest without effort when the abdominal muscles are normal and hip flexors are not seriously involved. By placing the fingers on the recti and lateral abdominal muscles, one can note the degree of paralysis and whether it is bilateral or unilateral. As contrasted with the 72 per cent. of affection of the abdomen in recent cases, the table of old cases shows 44.8 per cent of affection. This indicates a tendency of this paralysis to diminish in frequency and severity in the natural history of the disease; that is, the prognosis would seem fairly favorable for improvement.

TABLE 4.—INVOLVEMENT OF ABDOMEN, BACK AND NECK

	1916 Cases (948)			Old Cases (375)		
	Involvements		Ratio of Total to Partial	Involvements		Ratio of Total to Partial
	Number	Per Cent.		Number	Per Cent.	
Abdomen.....	686	72.3	1: 9.6	168	44.8	1:16.3
Back.....	128	13.5	1:21.9	55	14.6	1:20.2
Neck.....	103	10.8	1:49.5	27	7	0 total

Back.—The examination for paralysis of the back muscles is not as satisfactory or as accurate as most examinations, and slight degrees of weakness are apt to be overlooked. The tables show an involvement of 13.5 per cent. of the back in the patients in the recent group, and 15 per cent. in those of the old cases.

Neck.—Neck paralysis has evidently been largely overlooked, but frequently exists. In the recent cases it was present in 11 per cent., but in only 7 per cent. of the old cases. The normal patient, child or adult can lift the head against quite a little force when lying on the back. Weakness or paralysis of one or both sternomastoid muscles makes this impossible. This was the test adopted. From its relative infrequency in late cases, the prognosis is evidently favorable for improvement.

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Scoliosis.—The significance of recognizing abdominal paralysis is shown, for example, in connection with lateral curvature of the spine, with which it is often associated; 179 cases of lateral curvature of the spine were recorded, sixty-nine occurring in recent cases and 110 in old cases. The proportion of scliosis in the two classes of cases is interesting. In the recent cases scoliosis was recorded in 7 per cent., and in the old cases in 30 per cent. Scoliosis is therefore relatively four times as common in old as in recent cases, and is a late complication.

TABLE 5.—SCOLIOSIS AND ITS ASSOCIATED PARALYSES

	Old Cases		1916 Cases	
	Number	Abdomen Involved	Number	Abdomen Involved
One leg	10	5	10	7
Two legs	17	15	14	13
One arm	5	1	10	7
Two arms	3	1	5	4
One leg and one arm	3	2	3	2
One leg and two arms	2	..	..	..
Two legs and one arm	8	6	6	6
Four extremities	12	9	14	12
Abdomen and back	5	..	6	..
Short leg	41	6	..	..
No paralysis	4	..	1	..

In recent cases, involvement of the abdomen occurred in connection with lateral curvature in 75 per cent. of the cases, but in only 42 per cent. of the old cases. Apparently the most frequent cause of serious scoliosis is unilateral involvement of the abdominal muscles. Any affection of the abdomen in the early stage should make one watchful for scoliosis in the late stage.

Many unusual and previously unrecorded locations of paralysis were noted which will be discussed in a subsequent report.

TOTAL PARALYSIS

The two groups of cases were then analyzed with regard to the number and distribution of total paralyses of individual muscles occurring first, in the new, and second, in the old cases.

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In the recent cases, in 948 patients there were 2,352 totally paralyzed muscles, an average of two and a half totally paralyzed muscles per individual. In 375 old cases there were 1,622 totally paralyzed muscles, an average of four and a third totally paralyzed muscles per individual. Total paralysis was therefore relatively

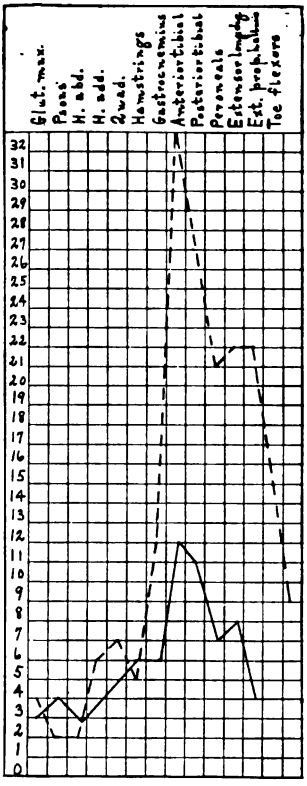

Chart 1.—Percentage of paralysis of each muscle in both recent and old cases in the lower extremity: solid line, recent cases; broken line, old cases.

more frequent in old than in new cases, a point the importance of which will be commented on later. As to involvement of the different muscles as to total paralysis, the following was the order of frequency in the lower extremity: Paralysis of the anterior tibial

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leads in both new and old groups. Next in order comes the posterior tibial, then the two extensors, the peronei, gastrocnemius, hamstrings and quadriceps, with a smaller number of total paralysis in the hip. The order of involvement does not differ materially in the group of new and of old cases. It has just been stated that there is a much larger proportion of total paralysis in old than in new cases to the individual, and an investigation was made to see if this occurred in any especial location. Chart 1 shows that the increased prevalence of total paralysis of the lower extremity in

TABLE 6.—TOTAL PARALYSES OF LOWER EXTREMITY IN ORDER OF RELATIVE FREQUENCY

	948 Recent Cases			375 Old Cases		
	Left	Right	Total	Left	Right	Total
Anterior tibial	123	124	247	126	120	246
Posterior tibial	114	119	233	104	102	206
Extensor proprius hallucis	73	79	152	87	73	160
Extensor longus digitorum pedis	78	71	149	86	77	163
Peroneals	75	72	147	78	78	156
Gastrocnemius	60	61	121	47	51	98
Hamstrings	57	59	116	20	22	42
Quadriceps	51	48	99	28	27	55
Hip adductors	47	38	85	19	27	46
Toe flexors	51	32	83	41	29	70
Iliopsoas	41	37	78	7	8	15
Hip abductors	37	32	69	12	8	20
Gluteus maximus	31	36	67	17	12	29
Totals	838	808	1,646	672	634	1,306

old cases occurs below the knee, and that in the thigh and hip muscles the proportion of total paralysis remains the same in new and old cases, but rises greatly in the leg and foot in old cases.

With regard to the upper extremity, the analysis of the total paralysis shows nothing of any great importance. The number of observations is relatively small, the muscular relations about the shoulder are very complex, and the study of the upper extremity from this point of view is less satisfactory than that of the lower. The paralysis of the upper extremity is most frequent in the deltoid muscle, and next follows the

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opponens pollicis, with the smallest number of total paralyses in the hand. The proportion of total paralysis is practically the same in old and new cases.

RELATION OF TOTAL TO PARTIAL PARALYSIS IN NEW AND OLD CASES

In the preliminary report[1] to the State Department of Health of Vermont in 1914, it was stated that the relation of total paralysis to partial in a combined

TABLE 7.—TOTAL PARALYSIS OF UPPER EXTREMITY IN ORDER OF RELATIVE FREQUENCY

	948 Recent Cases			375 Old Cases		
	Left	Right	Total	Left	Right	Total
Anterior deltoid	38	41	79	24	15	39
Posterior deltoid	36	40	76	19	14	33
Opponens pollicis	26	37	63	26	17	43
Outward rotators	19	16	35	8	8	16
Rhomboids	17	17	34	6	3	9
Latissimus dorsi	10	15	25	9	7	16
Biceps	10	10	20	7	2	9
Triceps	11	9	20	10	2	12
Lumbricales	8	11	19	9	6	15
Trapezius	8	10	18	5	5	10
Pectoralis major	6	12	18	13	6	19
Interossei	6	12	18	13	6	19
Thumb extensors	7	7	14	7	1	8
Serratus magnus	6	6	12	1	..	1
Wrist flexors	6	6	12	7	1	8
Thumb flexors	6	6	12	5	4	9
Supinators	4	7	11	8	2	10
Finger extensors	3	8	11	6	..	6
Pronators	4	6	10	8	1	9
Wrist extensors	5	5	10	5	3	8
Finger flexors	4	5	9	4	1	5
Totals	240	286	526	200	104	304

group of old and new cases was as 1 : 2.5. Since the beginning of the Vermont work, the examination for muscular involvement has become more accurate and more delicate and a larger number of weakened muscles are detected, which originally probably would have been passed as normal. This change would of course make the proportion of partial paralysis higher in relation to total than in the original Vermont figures because more muscles are now recognized as involved. This ratio will now be discussed in the New York

1. Lovett, R. W.: Treatment of Infantile Paralysis, THE JOURNAL A. M. A., June 26, 1915, p. 2118.

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cases, contrasting as usual the two groups of recent and old cases.

Taking the ratio of total to partial affection in all cases without regard to the location of the paralysis, the ratio was 1 : 5 in the recent cases, and 1 : 3 in the old cases. Examining further to see if this ratio differs in different parts of the body, if the lower extremity is considered alone in the new cases it is 1 : 4.2, and in the old, 1 : 2.8. In other words, the ratio of total to partial paralysis is very much higher in the lower extremity than elsewhere. Investigating now still further the lower extremity to see in which part of it this difference occurs, we find that in the leg and foot the proportion in new cases is 1 : 2.4 and in old cases 1 : 1.5. In the thigh, that is, in the quadriceps and hamstring muscles, in new cases it is 1 : 5.7, and in old cases 1 : 7. In the hip in new cases it is 1 : 7 and in old cases 1 : 11.4.

TABLE 8.—MUSCULAR INVOLVEMENT

	Paralysis		Ratio of Total to Partial
	Partial	Total	
Lower extremity:			
Patients of 1916 over 3 years	8,574	1,746	1:4.2
Old cases	3,618	1,277	1:2.8
Upper extremity:			
Patients of 1916 over 3 years	3,628	560	1:6.4
Old cases	1,662	285	1:5.8

In short, in the leg and foot the proportion of total to partial paralysis is very much higher in the old than in the new cases, but lower in the thigh and hip. The hip and thigh muscles become less affected and the foot muscles more affected as the years pass.

The proportion of total to partial paralysis in the foot and leg in old as contrasted with recent cases accentuates the observation already made as to the greatly increased proportion of total paralysis in the muscles of the leg and foot.

This seems a matter of the highest importance, and the reading of it seems clear. It may be assumed that when so large a group of cases is taken for analysis,

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minor differences between the characteristics of various epidemics will be eliminated and that the general behavior and type of the disease will be on the whole the same, and that therefore one may safely reason from patients paralyzed in 1916 to patients paralyzed in previous years.

This difference between the relative frequency of partial and total paralysis in the two groups may be met by one of two explanations: 1. Partial paralysis may clear up in the course of the years following the attack, leaving a larger proportion of total paralysis in these late cases. That this is not the case is shown by the fact that there is an absolute and relative increase

TABLE 9.—COMPARISON OF OLD AND NEW CASES

Location	Old Cases: Ratio of Total to Partial	1916 Cases: Ratio of Total to Partial
Leg and foot	1 : 1.5	1 : 2.4
Thigh	1 : 7	1 : 5.7
Hip	1 :11.4	1 : 7.2
Shoulder and arm	1 : 5.3	1 : 5.6
Hand and forearm	1 : 6.5	1 : 8.0

of total paralysis in the late cases as contrasted with the early ones. 2. The partial paralysis changes to total paralysis in the course of years. In this instance, total paralysis would become relatively and actually more common in the old cases, and the proportion of total to partial paralysis would become higher in the old than in the new cases. This is exactly what has happened here.

The question of interest in this connection is, Why should partial change to total paralysis after the first months following the attack? Here again we obtain suggestive data from the figures. The high occurrence of total paralysis in the old cases has been shown earlier in the paper to be almost wholly due to increase in the foot and leg. In the thigh, hip and upper extremity, there is no such increase, and if we looked only at these parts of the body, we should feel that the

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proportion between total and partial paralysis was about the same in new as in old cases. Where so striking a difference is found as exists in the foot between old and new cases, it suggests very strongly that there is some special reason for this difference, and this reason is quite evident when one considers the function of the foot in the months following the acute attack of infantile paralysis. Of all parts of the body, the foot has the maximum weight to carry; the work thrown on the foot is continuously heavy; in walking about and in standing there is no cessation of activity in these muscles, and if, as I have believed and

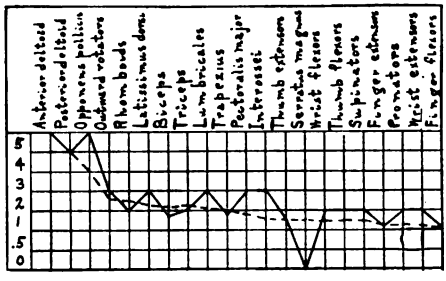

Chart 2.—Percentage of total paralysis of each muscle in both recent and old cases in the upper extremity: solid line, recent cases; broken line, old cases.

tried to teach for the last two years, fatigue and overuse are detrimental factors of the highest importance in the convalescent stage of infantile paralysis, it is in the foot muscles that one would look for the deleterious effect of overuse, and such deleterious effect would be the change from partial to total paralysis. In 1915 I[1] called attention to the fact that partially paralyzed muscles might lose power by overuse, and I have felt convinced that many a case of gastrocnemius weakness, for example, was converted into a total loss of the muscle by overuse and overtaxing by walking.

In the entirely unexpected result of the present analysis, made by assistants not familiar with my views on this matter, is to be found a confirmation of the

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opinion that I have held on the effect of muscular fatigue.

It may be permissible to call attention once more to just what these figures show: 1. Total paralysis is relatively much more frequent in patients paralyzed prior to 1916 than in patients paralyzed in that year. 2. The proportion of total to partial paralysis in the whole group of new cases is less than in the whole group of old cases. 3. When this matter is analyzed, it is found that it is due almost wholly to conditions in the muscles of the leg and foot in which the proportion of total to partial paralysis is very much higher in old than in new cases, whereas in the hip and thigh it is relatively less in the old cases than in the new. 4. The interpretation of this that seems best to fit the fact is

TABLE 10.—AVERAGE AFFECTION OF EACH MUSCLE GROUP, FORTY-NINE CASES, IN PERCENTAGES OF NORMAL STRENGTH

Group	Per Cent.	Group	Per Cent.
Plantar flexion	41.5	Abduction	41.0
Dorsiflexion	32.5	Hip extension	51.2
Inversion	28.2	Hip flexion	54.5
Eversion	36.5	Knee extension	34.5
Adduction	42.5	Knee flexion	37.0

that in the months following the attack when walking is begun, the activity of weight bearing constitutes such gross overuse of the leg muscles that not only are they kept from improving, but also weakening is converted to total paralysis. This is only to be expected if one looks at the facts. The lowering of power in the weakened muscles of the leg is considerable, as the following will show: The records of forty-nine cases of leg paralysis were taken consecutively from the files for analysis as to the degree of involvement in the different leg muscles, as shown by the spring balance test. The power remaining in each of the groups of the lower extremity ranged from 28 to 52 per cent., with an average of 41 per cent. (Below the knee the average of all groups was 34.6 per cent., above the knee 41 per cent.)

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Whatever may be said in its favor, walking on a muscle which is reduced to 30 or 40 per cent. of its normal power is a very serious tax on that muscle's endurance, and however much one may be a believer in exercise, the use of such muscles for weight bearing and walking is not desirable from what we know of the physiology of muscles. These data taken together bear out a perfectly clear conviction on my part, already definitely expressed, that walking to any extent, with or without braces, in the first year after an attack of infantile paralysis not only tends to delay the improvement of partly paralyzed muscles and is liable to set a limit to their final restoration, but may also change them from the class of partly paralyzed to totally paralyzed muscles.

TABLE 11.—NUMBER OF PARALYZED GROUPS OF MUSCLES, PARTIAL AND TOTAL (LEFT AND RIGHT)

	1916 Cases		Old Cases	
	Left	Right	Left	Right
Upper extremity				
Hand and forearm	853	913	505	425
Arm	1,121	1,301	562	455
Total	1,974	2,214	1,067	880
Percentage	47%	53%	55%	45%
Lower extremity				
Hip	1,450	1,346	707	737
Thigh	721	745	390	398
Leg and foot	2,087	2,071	1,343	1,320
Total	4,158	4,162	2,440	2,455
Percentage	50%	50%	50%	50%

If weight-bearing exercise is detrimental in the first year after the paralysis, and leads to muscular deterioration, most marked where the weight is greatest, one may well inquire whether these tables give any information as to the effect of nonweight-bearing muscular exercise on the progress of paralysis.

DIFFERENCE BETWEEN RIGHT AND LEFT SIDES

From a study of the upper extremity, one may see the effect of nonweight-bearing exercise, and one

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may go farther and study the effect of the different activity of the right and left hands on the recovery from the paralysis. The function of the two hands is different, the right being used much more freely and continuously than the left, and for more finely coordinated movements, so that in the contrast of the two the effect of nonweight-bearing exercise may be analyzed. As a control, one may take the lower extremities, the function of which is similar. Analysis of the figures shows that the right and left legs are affected exactly alike in new and old cases. Both as to the actual number of paralyses of all grades, and as to the number of totally paralyzed muscles, the per-

TABLE 12.—DIFFERENCE BETWEEN LEFT AND RIGHT SIDES

	Lower Extremity		Upper Extremity	
	Left, Per Cent.	Right, Per Cent.	Left, Per Cent.	Right, Per Cent.
All paralyses, total and partial:				
1916 cases	50	50	47	53
Old cases	50	50	55	45
Total paralyses by individual muscle groups:				
1916 cases	51	49	46	54
Old cases	52	48	64	36

centage is practically 50 for right and left in both groups. In the upper extremity recent cases show a slightly greater involvement of the right arm in cases in which all grades of paralysis are noted, 54 per cent. being on the right side in new cases. In estimating total paralyses of the upper extremity, there were found 36 per cent. on the right and 64 per cent. on the left, in old cases.

In other words, all grades of paralysis and particularly the total form, are about the same in the right and left arms in the beginning, but very much less in the later cases in the right arm, whereas, in the legs, the frequency of both right and left is the same in early and in late cases, from which one may infer that nonweight-bearing exercise is beneficial, as shown by the greater improvement of the right upper extremity.

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CONCLUSION

The conclusions presented in this paper have been derived from an impartial study of a large number of figures obtained from carefully studied cases. They seem to show that weight-bearing exercise, such as walking to any extent in the first year after infantile paralysis, is apparently attended with risk and is followed in many instances by a change from partial to total paralysis in the foot muscles, whereas in other parts of the body this deterioration does not occur.

The evidence of these figures is also definitely to the effect that the right hand recovers much more effectively than the left, which may be interpreted as showing that the use of nonweight-bearing exercise is beneficial.

It is gratifying to find clinical experience indorsed by an independent statistical examination, and I should like in closing to go definitely on record to the effect that I believe that the weight-bearing use of the muscles with or without braces, in the first year following infantile paralysis involving one or both legs, is risky and detrimental if practiced to any considerable extent, and that by the use of nonweight-bearing therapeutic muscular exercises conjoined with little or no walking, in cases affecting the leg, it is possible to secure a class of results with which I, for one, had been previously wholly unfamiliar.

ABSTRACT OF DISCUSSION

ON PAPERS OF DRS. HERRMAN, SHAW AND LOVETT

Dr. Haven Emerson, New York: Until the parents know enough to call a physician and the physicians are in a position to make a reasonably quick diagnosis of the disease, and until they report the cases at once to the authorities, it is unlikely that any methods of protection other than those that the individual physician directs can be employed.

I should like to indicate two matters that, as a department, I believe we have learned from this epidemic. In the first place, there is no evidence that environment plays any part in the development or spread of the disease. We have abandoned the old process of fumigation, which was done in the belief that by making a smell in the room, the persons who had the disease could be kept from spreading it to

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others. It was necessary to consider whether environment had a bearing on the spread of the disease. Everything, however, pointed to personal communication as the source of the infection, rather than to infection from the premises. There was nothing to point to home environment; nothing to point to the character of the diet, unclean food, unclean air, dirty streets, or anything else of that kind as having a relation to the spread of the disease.

Institutions in New York City are under the supervision of the department of health as to the manner of housekeeping of the institution. There were 28,000 children in these institutions. A quarantine was placed on them on July 1, and visitors were excluded. The children were not allowed to be at large in the community and acquire infection in that way. No children were admitted to any of these institutions without a three weeks' isolation period. The result was that only twelve cases of poliomyelitis developed among the 28,000 children in these institutions during the entire summer and fall. Of these twelve cases, only three developed after July 14. That shows that it is possible by physical separation to accomplish some sort of protection for groups of children. Dr. Herrman's suggestion that we isolate the susceptible, if we know them, would offer a chance of protection to the community.

During the past month there have been three deaths reported as due to poliomyelitis. One of these, at necropsy, proved to be cerebral abscess; another, cerebral tumor; and the other, epidemic cerebrospinal meningitis. The community has learned to expect and demand of physicians spinal puncture as a diagnostic procedure.

It is apparent, from some of the studies made in these children, that those who have normal throats are less susceptible to this disease than are those who have abnormal throats.

We have planned to treat this disease this year and in the future much as we do scarlet fever or measles, or any other communicable disease. It has been agreed by the city and state health officers independently that the period of isolation for this disease should be three weeks. If the children who have been sick and have recovered from the disease still continue, after three weeks' isolation, to have a temperature or discharges from the nose and throat, their isolation period should continue, as in the case of scarlet fever. We make one other exception in regard to isolation, in that people concerned with preparation and handling of food have an opportunity of spreading fresh nose and mouth infection through food more directly than is the case of other industries. Therefore, we expect to limit the freedom of adults engaged in the preparing and serving of foods, if they are members of a household where there is infection. It may be that food does not serve as a carrier; but it makes

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a poor impression on the community to have a person taking care of a sick child in the back room, and serving food to people in the front. I think it is wiser, in this city, to limit the people who are permitted to deal with the handling and preparation of food to those who are free from any obvious contact with such infective diseases as may be carried by hand and mouth infection. We are prepared as if expecting a return of the disease in epidemic form, but so far this year there is nothing to indicate any undue increase or incidence of poliomyelitis in New York City.

Dr. C. L. Dana, New York: This spring it was decided to appoint a joint committee of the Academy of Medicine Public Health Committee and the Neurological Society to make some investigation of the poliomyelitis situation. One of our committee, Dr. Wilson, made a careful study of the relative immunity to the disease in relation to the age of children as compared with other infectious diseases. He showed definitely that the period of greatest susceptibility runs from the second to the fifth year in poliomyelitis, corresponding fairly well with that of the other infectious diseases of childhood, with the exception of whooping cough. The conclusion is that immunity to poliomyelitis is not due to a great prevalence of abortive or unrecognized attacks of the disease, but that it is a natural immunity, just like the immunity to other infections.

We found that the disease is not personally or immediately contagious, except to a small extent. The evidence of this is based on the small number of family cases, on the absence of spread of the disease among unprotected children in hospitals, schools, day nurseries and institutions, and on the small number of instances which can be really interpreted as proving personal contagion. We believe, however, in quarantine; and, in general, commend the methods lately adopted by the city board of health. We also believe in hospitalization of the patients. No epidemic developed in any of the very large number of hospitals and other institutions in New York. A child in a hospital is safe from the disease, even if other cases are brought in. If people cannot send the child to a hospital, we have drawn up a memorandum of precautions that provide for hospitalization in the home. One of the things that seemed most in favor was the frequent puncturing of the spinal canal during the early stage of the attack. We feel sure that the best methods of treatment of the paralyzed are those described as indicated in paralysis from nerve injuries. The use of the Martin spring balance in testing and treating cases is also an addition to the later therapy of the disease.

Dr. Herman Schwarz, New York: I feel very strongly that in this large audience we cannot let pass the statement of the neurologists about the noncontagiousness of the dis-

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ease. I am not going to quibble about the terms contagious or infectious. I might say, however, that we saw a great many cases last summer in which, in most instances, there was a history of contact with another case. If the neurologists had been doing the field work they would certainly have the impression that, if anything, it might be called "catching." If you had gone into 300 families where there had been one case, and had heard histories of other children having had sore throats, or malaise, you would also be convinced that the incidence of the disease during an epidemic is much greater than the figures show. I should say that there were many thousands more than reported, these cases being too mild to give any definite symptoms whatever.

It was one of the commonest things to find another one or more children in the family having been just slightly ill, either before or after the so-called real case of infantile paralysis was reported. I know many of these cases were poliomyelitis, for lumbar puncture was performed for the most trifling symptoms and increased number of cells found in the fluid.

At present I don't think it is fair to say anything about the degree of contagiousness, but to say that it is not contagious, I believe is going too far.

The cell count in the prognosis of the disease has not been of tremendous help to us.

Dr. E. C. Rosenow, Rochester, Minn.: All of us, after listening to this symposium, must feel how helpless we still are in the control and treatment of poliomyelitis. The serum of patients who have recovered from poliomyelitis obviously cannot be used on a large scale. From the work of Flexner and Noguchi, Amoss and others, it appears that at least abortive attacks of poliomyelitis are necessary in order that neutralizing and protective substances may be produced in the serum. This, it is claimed, is true in the experimental disease in the monkey both from virus and from cultures of the globoid organisms. Amoss' recent work emphasizes the fact that the globoid organisms have, indeed, little antigenic powers. The hope of obtaining a satisfactory remedial agent along these lines appears to me to be small.

A restudy of the bacteriology of poliomyelitis in the recent epidemic has shown the presence of a peculiar pleomorphic streptococcus in atria of infection in the central nervous system in human poliomyelitis and in the brain and cord of monkeys paralyzed with virus. Intravenous injections of this organism soon after isolation produced flaccid paralysis with lesions in the central nervous system in animals. The apparent relation between the large aerobic form and the small anaerobic form has been discussed in a published report. It occurred to me that injections of the large form might call forth a greater production of antibodies in general, as well as antibodies protective against virus. Accordingly, we have

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immunized a number of horses with aerobic cultures of the pleomorphic streptococcus, and their serums have been tested from time to time as to antibodies and neutralizing and protective power against virus. One horse was injected chiefly with strains recently isolated from monkey poliomyelitis, and another with strains isolated last summer from human poliomyelitis. The serum from both has developed the power to agglutinate in high dilutions (up to 1 to 1,000,000) the strains from human and monkey poliomyelitis. Neither of these serums agglutinate in high dilutions strains of streptococci from other sources, nor do antipneumococcus and antistreptococcus serums agglutinate the pleomorphic streptococcus. The serum from the horse which had been injected with recently isolated strains from monkeys has apparently developed the power to neutralize virus in the test tube and in the monkey. Three monkeys injected intracerebrally with active virus were protected from poliomyelitic attacks by repeated intraspinal or intravenous injections of this serum, beginning soon after injections of virus. Moreover, ten out of thirteen monkeys recovered from typical poliomyelitic attacks following injections of this serum after the symptoms had begun. Nearly all of the untreated controls, and those injected with normal horse serum, died during the attack.

These observations, while too few from which to draw sweeping conclusions, afford strong evidence that the pleomorphic streptococcus isolated so constantly from the central nervous system bears etiologic relationship to epidemic poliomyelitis, but final conclusions can not be drawn as to the exact rôle it plays until a true virus is established.

Dr. Reginald H. Sayre, New York: The great field in poliomyelitis is, of course, prevention; and I hope that Dr. Rosenow may show us how to prevent these patients from becoming paralyzed. What Dr. Lovett has told you about the danger of overexercise in the first year cannot be too strongly emphasized; and the danger of overwork in the first few weeks and months, and also the danger of not noticing a slight paralysis of the trunk and allowing these patients to sit up in a chair. Being propped up in this way is responsible for many lateral curvatures of incurable form, for which the patients later come for treatment. These children are best lying on their backs, and not being encouraged by the nurse, and often by the physician, to do work that their muscles are incapable of performing.

How long after the acute attack is it wise to attempt to do things for these patients? Before coming to that, I should like to say that the wisdom of judiciously directed work cannot be overemphasized. The same facility that a pianist gets by constant practice, the same reeducation of his telegraph lines from his brain to his finger tips, is the thing which will give us results in those paralyzed cases in which there is some power of regeneration of function still left.

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When should one tell the parent that it is useless to proceed with this sort of treatment? I do not know; because years afterwards, when the patient had been abandoned and nothing was being done, the child being left to crawl on the floor because treatment had been considered useless, I have seen cases of that sort gain a great deal of power by the intelligent application of exercise—sometimes combined with support, and sometimes not. Some of my neurologic friends have said that support is useless and should not be applied, because it has a bad effect on the child's mind; but I think it has a worse effect on its mind to have it crawling around, not being able to walk. To give it the ability to move around and exercise with its playmates by the intelligent application of apparatus, I consider a much better procedure.

I agree with Dr. Lovett that in the early stages it is better to leave the child unhampered by apparatus. It is only in the later stages that it needs support. The question of what shall be done (the application of apparatus or such operations as arthrodesis or neurotization of muscles) is one for the late stage of the disease, after several years have passed; not in the immediate condition that confronts us in the children of last year's epidemic; and the people who rush in and operate in the early stages will prevent the patients from having the chance of recovery which nature may afford them later on.

Dr. Horace Greeley, Brooklyn: What I wish particularly to call attention to in regard to the etiology of poliomyelitis, are the conclusions of an article of mine in the July number of the *Journal of Laboratory and Clinical Medicine*. In this article it is shown that "globoid bodies," cultivated from poliomyelitis pathologic material, under the conditions mentioned by Noguchi and others, may be also grown in another form, at temperatures paralleling those prevailing during the prevalence of the disease; that is, about 70 F. At this temperature, these globules assume a bacillus form, similar in characteristics to the gram-negative bacillus sometimes spoken of as the bacillus of distemper. (These characteristics may be brought out at body temperature through the use of a special limewater containing a medium described in the article.) I believe that the organisms of poliomyelitis and of distemper are markedly affected by environment, and that they are one single organism, changing somewhat in character in passing from one group of animals to another. My conclusion in the article quoted was that the organism isolated from patients with poliomyelitis is a pleomorphic bacillus, and that the various forms—globoid bodies, cocci and bacilli—are not different organisms, but only manifestations of pleomorphism in the same organism, as affected by environment; and that this organism is the same as that found in the dog, cat, and other domestic animals when suffering from distemper.

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The organism, as shown in my article, is saprophytic, and grows well at "summer heat." It grows well in milk at "summer heat" and resists the pasteurization process while contained therein. It forms spores and is a filter passer.

You all recollect that the commission that investigated the Washington, D. C., outbreak of 1910, reported that during the course of the epidemic the temperature varied between 69.7 and 77.6 F. In New York City the temperature during last year's epidemic was evidently an important factor as the following table shows:

POLIOMYELITIS IN NEW YORK CITY IN 1916

Month	Mean Temperature, F.	Cases
May	59.3	29
June	64.2	756
July	73.8	3,863
August	73.6	3,306
September	66.0	780
October	57.2	193

All other epidemics have also been associated with "summer heat" temperatures, and the reasons of such associations are, I think, explained by the findings of the article in question.

DR. WILLIAM C. HAGER, Brooklyn: There are three essential points that the medical profession at large—that is, the general practitioner and the pediatrists—are interested in, and the public also: first, how the disease is transmitted; second, how the diagnosis may be made early; and third, how the disease may be treated. You have heard this morning that this is not a contagious disease. That is a matter of terms merely. It is surely communicable. Let me cite one or two cases that I saw myself last year.

A child died in Brooklyn, after thirty-four hours' illness, without a diagnosis. An old woman of 52 years took care of the child almost constantly. She came down, one week later, with a disease of which no diagnosis was made; but after two weeks of inability to walk she was transferred to a hospital, where she remained two weeks and the diagnosis of meningitis was made. A spinal puncture was made, but no definite results were obtained from it. After another two weeks she was discharged, able to walk; but when I examined her she had definite weakness of one leg and inability to raise her left arm. When she was discharged from the hospital she went to her son's house in Queens. There had been no cases of poliomyelitis in that neighborhood previous to this time. Six days later a child in that family came down with poliomyelitis and was taken to the hospital. A day or two later, another child, a nephew of her son, but living in another house, who had visited at his uncle's but one day

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after she arrived, came down with poliomyelitis and went to the hospital. She then went to a house five blocks away to look for rooms, and took the upper floor of the house. While there, she sat on the porch with the four children of the family, and they all drank water and grapejuice together. One week later one of the children in that house came down with the disease. Perhaps she did not have it.

The diagnosis in the typical cases, which constitute the large percentage of these cases, is possible before paralysis occurs. It should be made as surely as that of any other infectious disease in the typical cases, and most of them are typical. It can be made, first, by the fact that we are dealing with an acute infection of some kind; and secondly, by the fact that we get, as the second stage, involvement of the central nervous system definitely. It may be something else, but the symptoms of the typical cases are very suspicious. Then the spinal puncture will determine the diagnosis absolutely, and that can be made, if the cases are seen early, before paralysis has occurred. That is most important, from the public health point of view; but it is also of the utmost importance, if the children are to receive proper care and a proper line of treatment. Let us all combine on early diagnosis.

The third essential point is treatment. I was, and still am, as hopeful as any one that we can find a serum treatment. I think that will come. The theory of immune serum was excellent; but, on the face of it, it is not useful, because the antibodies produced by nature are sufficient to give sure protection to the individual actively immunized; but when you take a small amount of serum and dilute it, the dilution brings it, in most cases, below the stage of very active power. If we can produce active immunity, that may be another possibility.

Dr. Henry Keller, New York: One thing struck me as very peculiar, namely, that so few of the patients suffering from tuberculosis of joints have been attacked by infantile paralysis. I have seen none. I have also asked Dr. Lovett about it and he could not recall a single case of his own. I have brought up that same question before the Orthopedic Section of the New York Academy of Medicine, and only one of the men could recall a case. I cannot account for it, and am anxious to hear from some one who can.

Dr. Lovett emphasized, and very properly so, that it is essential to keep the patient at rest for a long time, because, by giving the muscles a chance to rest, especially the weight-bearing muscles, the nerves may régenerate. The difficulty, however, is to keep the patient quiet if only few muscles of a group are involved. If the children are paralyzed so extensively that they cannot walk, they will not resist being kept at rest. It is different, however, when only few muscles are

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involved. I have tried time and again and did not succeed. The parents come back and say that they can not keep the child quiet. Hence, after the quarantine period is over, one is compelled to apply some kind of apparatus, or a plaster-of-Paris bandage, in order to have the child walk properly—for it will walk whether you want it to or not.

One point which has a practical bearing on treatment, especially in paralysis of the leg muscles, is that muscle groups helped by gravity are usually the weaker muscles, while muscles working against gravity are the stronger group. In the muscles of the foot the same rule holds good. The everters are the weaker muscles while the inverters are the stronger group. Now, if the peroneal group is attacked by paralysis, the inverters being very strong, will produce a marked varus deformity in time, unless restrained early in the disease by proper bracing. On the other hand, paralysis of the inverters will not be followed by any marked deformity provided ordinary care is taken to keep the foot within the weight line; that is, building up the shoe one-sixth to one-third inch on the inner border is often sufficient.

Lastly, it is well to bear in mind that a joint is only incapacitated in virtue of the paralysis of the muscles surrounding it, and hence, in the application of a brace, one must see to it that the muscles, as well as the joint, are supported. In quadriceps extensor paralysis, for instance, with a resultant hyperextension of the knee, a short brace reaching to the middle of the thigh does more harm than good, because it cuts the very muscle which it should support. A long brace with a pelvic band to support the muscle from its origin to its insertion is the only efficient brace, and no other.

Dr. George Draper, New York: It is impossible for me not to take this opportunity to add my strongest and most emphatic approval to the remarks of Drs. Shaw and Schwarz on the subject of contact distribution of this disease. It was most surprising to hear the report from the committee of the New York Neurological Society and the New York Academy of Medicine that poliomyelitis is not spread by contact. This judgment, apparently, was based on secondary reports. It is impossible to know an epidemic disease unless you see it in its whole course in the field. It is necessary to go where the disease is and see it, feel it, and smell it—for there is a peculiar and distinct smell to these cases in the acute stage. The neurologist who takes the stand that it is not transmitted through contact, and minimizes the value of quarantine, surely cannot have been in the field with the acute cases, and assumes by his position a grave responsibility before the community.

The so-called prodromal stage, as mentioned by Dr. Tilney, is not prodromal, it is the disease itself; and the abortive

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type, which Wickman described, is analogous to the first or systemic phase of the disease. The paralyses are incidents in the course of an acute general infection.

I cannot help reiterating that poliomyelitis is an acute contagious disease, and a serious menace to the community. The only hold we have on it at present is to treat it as being spread by contact. Unless we try to check immediately the nonparalyzed cases, and healthy contacts who may be carriers of infection from the sick cases, so that secretions and excreta cannot be transferred, we shall again, in some localities, have the trouble that we had last year. This is no time to take the position that it is not a contact disease.

Dr. Charles Herrman, New York: I am a pediatrist, but I think the neurologists may have been misunderstood. The figures are perfectly true: 252 secondary cases occurred in the families that were attacked in New York City. That, in itself, is sufficient to show, beyond all doubt, that the disease is communicable. If I understood correctly, the neurologists make a distinction between contagious and communicable, and think that people are not infected by the patient, but by a person who carries the disease. I do not think they mean that the disease is not communicable, but that the vast majority of cases are caused by carriers.

With regard to the percentage of other children exposed in the families in which a case occurred, I would say that I mentioned that 5 per cent. of the other children in the families exposed had some symptoms. We cannot say definitely that they had a mild attack of poliomyelitis, but they had some symptoms, fever, vomiting, tonsillitis, that might have been due to such an infection. We must assume that a large percentage of these children are practically immune.

With regard to adenoids and tonsils, my investigations show that they were not more common in the children with poliomyelitis than in the others. Twenty-five per cent. of all the children in New York have adenoid vegetations and enlarged tonsils, and in the poliomyelitis cases, the percentage was not perceptibly larger. So I do not think that it is so much a question of their presence as of some lack of normal power to neutralize and inactivate the virus of poliomyelitis in certain individuals. Why, I do not believe anyone knows; but certain individuals lack that power, which is normal in a large percentage.

I believe it should be emphasized that we are not likely to have another large epidemic of the disease within a few years in New York City. The figures show that pretty well. There were seven thousand undoubted cases in children under 5 years, with distinct paralysis. That represents 1 per cent. of the children under 5 years in New York City. If we assume that an equal number who were exposed had a mild attack, were thus immunized, we would have 2 per cent. That is a large percentage of the total number of children

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under 5 years who are susceptible, and I do not think that it is likely that we shall have another large epidemic here, for some years, at least.

Dr. La Salle Archambault, Albany, N. Y.: I quite understand the attitude that is taken by Dr. Draper. The views that I have expressed concerning the pathogenesis of poliomyelitis are so directly opposed to the doctrine prevailing at present that I can see how difficult it must be to accept them without further evidence. I did not have an opportunity to go into all the facts that I had hoped to present. A point that, in my opinion, cannot be contested, however, is that I have found in the bloodvessels of the Rolandic area, the pons, the medulla, the cervicodorsal cord and the spinal pia, unusual numbers of white cells. There were some polymorphonuclears, but most of the cells were lymphocytes and polyblasts, analogous to the infiltrating cells of the central gray matter. These sections were seen by other men, and I want to add that my preparations are at the disposal of those interested.

There is one point in this connection that I believe has considerable practical bearing. If it is true that the virus of poliomyelitis is carried into the cerebrospinal axis through the bloodstream, we should follow up treatment in the same way. Reading the very careful reports of the serum treatment of poliomyelitis in New York last summer, I cannot say that I was favorably impressed with the reactions obtained. A number of cases did remarkably well, but I do not believe that it was possible to say that the amelioration or recovery was due to the serum in these cases. In a large number of instances the patients were made decidedly worse and must have caused considerable anxiety to the attending physician. It seems to me that if the hematogenous route represents the path by which the cerebrospinal axis is involved, and I believe that it does, we should give the serum intravenously. In that way, much larger quantities can be employed. We must remember that the meninges and their bloodvessels are sufficiently disturbed already, and that the introduction of the serum into the subarachnoidean space acts much as an irritant, simply aggravating the condition and perhaps, in some instances, making the case hopeless. A better result might be obtained by the intravenous route. I would suggest, however, that lumbar puncture be performed before the administration of the serum.

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REPORT OF COMMITTEE ON ORTHOPEDIC PREPAREDNESS

Your committee appointed to consider the question of the orthopedic preparedness of our nation desires to make the following report, and as the purpose of the committee is identical with that of a committee having the same chairman appointed at the last meeting of the American Orthopedic Association, the report here presented is identical with that to be presented to this other organization, the two committees having been in close cooperation.

That there is a very large place for the orthopedic surgeon in the military organization of our country, there can be no question. The situation in Europe, with the splendid work of the men of our specialty and the conspicuous part which they are being asked to play in the reconstruction and occupational reeducation of the wounded, should make us consider most seriously our own situation, so that in case of need we may be found ready.

Aside from this, even where war does not exist, the orthopedist still has his place in the military organization, and in the mobilization of the troops on the Mexican border the opportunities for such service were many. The great numbers of men invalided because of weakness of the feet, as well as the cases of weak low backs, gave probably the most obvious opportunities for assistance and direction.

Your committee feels that its recommendations should cover conditions as they exist in times of peace as well as in times of war. For the former, the recommendations made with reference to the military organization would be of almost equal value to those outside this organization, and especially that great body often spoken of as the industrial army, the importance of the fitness of which, in time of war, is scarcely less than that of the army that does the actual fighting.

This work should include instruction in the proper development of the body, with periods of "setting up" drill, with instruction in the proper use of the body in the special occupation, so that there will be the least strain and liability to disaster, instruction in the choice of shoes or other garments, which if wrongly selected could do harm, as well as practical instruction in the general fundamentals of health. It is obvious that the health and efficiency of an army, whether industrial or fighting, depends on the intelligence of the individual, and that reasonable instruction can be given that will make this intelligence of such a character that a

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high order of efficiency can be expected. In illustration of what can be done along these lines, in the mobilization of the troops this last summer one of the regiments had as its medical director an orthopedic surgeon who had seen that his men were given a few (three) simple exercises to strengthen the feet. This regiment in a ten mile "hike" in Texas brought in all its men on their feet. Another regiment from the same city, and therefore from similar conditions, had had no such training, and in the same ten mile hike between 300 and 400 men were brought in in an ambulance or on motor trucks because of their feet.

Another concrete illustration of what the orthopedist can do was also demonstrated in the mobilization of the troops last summer. It was there shown that the army shoe as then made is admirable for those having the intermediate and heavy type of foot, but that for the slender, high arched type of foot it was much too broad and too low in the shank. The making of the narrower widths with higher shank and narrower heel, a change already accepted, makes it possible to meet the need of the slender feet without changing the appearance of the shoe or disturbing the widths naturally used by those having the broader feet.

Along such lines as these the orthopedist has his place, and while perhaps not as dramatic as that which involves fighting, may, nevertheless, represent quite as much a service to our national life.

In case of war there are two kinds of service in which the orthopedic surgeon finds a definite place.

The first is in connection with the work of the base hospital, which is located comparatively near the actual conflict, and to which the men are sent as soon as the first dressings are applied at the field hospital or first aid station.

These hospitals are naturally under the direction of general surgeons, and the orthopedist's position is that of assistant, the cases in which special mechanical problems exist being turned over to him for care.

Since in times of conflict the beds in the base hospital are in great need for the freshly wounded men who are constantly coming in from the front, cases which require long treatment cannot be kept, but must be sent farther back. A service of this kind must necessarily represent largely acute emergency work, and much of it will consist in getting the patient into condition for transfer to some other hospital where the treatment can be completed.

The second form of service that is open to the orthopedic surgeon in time of war is that which would be rendered in hospitals to which patients would be sent from the base hospitals, and kept for as long as necessary, not only for the purely surgical treatment, but for such reeducation along

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occupational lines as is indicated, so that when discharged there will be the least possible physical handicap, with the greatest amount of industrial fitness. Such hospitals are designated by the Army and the Red Cross as general hospitals for orthopedic (or other specialties) purposes. They should be located in or near large centers, since this insures the greatest ease in officering and equipment. The staff would naturally be made up of men skilled in orthopedic surgery, with such other members as might be needed for consultation or special purposes.

No hospital of this sort should be established with less than 200 beds. Smaller units are difficult to officer and are inefficient.

The hospitals can be built for this special purpose, and with simple temporary construction the time required for their erection should not be great. In Canada buildings have been occupied in as short a time as sixteen days.

A still better plan, where it is possible, is to use some already existing institution, the work to be either taken over entirely by the government, or for the government to pay to the existing management for the care of the patient on a per diem basis. The staff would naturally be under the government. Such an arrangement as this would probably insure the best equipment for less expense than specially erected plants. If the ward capacity of such an existing institution is not large enough, adjoining property can often be acquired for the erection of tent wards or temporary shack wards. Park property is often available for such purposes.

As a type of this form of cooperation and organization, a hospital unit has been worked out in Boston with the Robert B. Brigham Hospital and the city of Boston. This hospital, which is designed for the chronic cases, many of whom are crippled, is equipped not only with the usual operating rooms, Roentgen-ray outfit, laboratory facilities, etc., but has a fully equipped hydrotherapeutic plant and an organized industrial department for occupational training. Adjoining the hospital is a park belonging the the city of Boston, and this is so laid out that tent or shack wards can be erected on it that would accommodate about 500 patients. On the land of the hospital proper additional space for 100 or 200 patients is available if needed. The service, heating, and power plant of the hospital is adequate, except as the corps of workers in the different departments would need to be enlarged. In this way in the shortest possible time and with the least expense to the government, efficient care of 500 or 600 men is available.

The organization of the staff for this orthopedic hospital has been worked out in the light of the experience abroad, on the basis that one chief of service could be responsible for 250 patients. The assignments are as follows:

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STAFF

	First Service	Second Service
Surgeon-in-Chief	E. G. Brackett	C. F. Painter
Surgeon	L. T. Brown	M. H. Rogers
Surgeon	M. S. Danforth	L. T. Swain
Laboratory Director.....	F. H. McCrudden	
Roentgenologist	Lawrie Morrison	
Chief of Anesthesia.....	Freeman Allen	
Internal Medicine.....	Louis M. Spear	
Internal Medicine.....	Charles H. Lawrence	
Dental Surgeon.....	Walter C. Miner	

In charge of the physical therapy, including the muscular reeducation, etc., Miss Marguerite Sanderson and Miss Marjorie Bouvé, of the Boston School of Physical Education.

A considerable number of those who would be needed to expand the various departments for the hospital administration have already been pledged.

EQUIPMENT

For the special equipment of such a hospital the following list of articles is to be desired, and this would apply equally well to the orthopedic needs of a base hospital. The ordinary surgical instruments are not indicated, as the United States government has worked out a standard list of such articles and would see that they are provided. The articles specified are such as are considered desirable by those who have seen service in Europe and are familiar with the kind of work that war as at present waged produces.

REQUISITIONS FOR GENERAL HOSPITAL FOR ORTHOPEDIC CASES

Materials

1 Hawley table (Kny-Scherer Co., N. Y.).
1 Goddu portable spica support (F. H. Thomas Co., Boston).
500 5-in. 5-yd. plaster bandages in Chinese napkin with elastic and stored in air tight tin container.
1 barrel Caproni plaster for bandages.
2,500 5-in. 5-yd. crinoline (starch sized, not more than 40 to 50 threads to inch).
2 webs of crinoline (starch sized, not more than 40 to 50 threads to inch).
200 feet (10-ft. lengths) soft iron ¾ in. wide, 1/32 in. thick.
200 feet (10-ft. lengths) soft iron ¾ in. wide, 3/32 in. thick.
5,000 feet (14-ft. lengths) 2 in. by ⅞ in., all sides planed soft wood.
200 feet (10-ft. lengths) Bessemer copper coated steel wire 10/32 in. diameter.

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200 feet (10-ft. lengths) Bessemer copper coated steel wire 9/32 in. diameter.
200 feet (coil) Bessemer copper coated steel wire 9/32 in. diameter.
25 sheets medium weight tin.
20 large size Thomas groin anterior split rings, angle 55° with uprights, 19/32-in. Bessemer copper coated steel wire, uprights attached, 40-in. lengths (William Krause, Boston, 18 Cambria Street).
20 small size ditto.
25 yards heavy, ½ in. thick, soft gray felting (double width).
50 yards body size stockinette No. 3 (Lowenthal & Bros., Rochester, N. Y.).
50 yards leg size stockinette No. 1½ (Lowenthal & Bros., Rochester, N. Y.).
5 yards arm size stockinette No. 1 (Lowenthal & Bros., Rochester, N. Y.).
1 bale white or gray glazed sheet wadding (long length, wide width).
12 gas pipe (1 in.) 6 ft. by 2 ft. Bradford frames.
24 covers (2 sections) laced.
1 quart Heusner's Glue (Mass. Gen. Hospital apothecary).
4 dozen flannelette extensions.
1 dozen rolls 10-in., 5-yd. Z. O. adhesive plaster.
3 sides mineral tanned gray leather (Wright & Wright, 109 Lincoln Street, Boston).

Instruments

1 pair plaster cutting shears.
1 dozen small knives for cutting plaster (made by Murphy, Ayer, Mass.). Sample enclosed.
1 motor saw (Albee pattern) (Kny-Scherer Co.).
1 fiber or wood mallet, 4 in. length head, 2 in. diameter.
1 osteotome, ⅝ in. wide.
1 osteotome, ½ in. wide.
1 osteotome, ⅜ in. wide.
1 osteotome, ¼ in. wide.
1 rotary drill and Morse twist drills Nos. 16-24, and 32.
6 Steinmann pins and calipers.
3 dozen Gigli saws.
2 coping saws (metal with blades) (any hardware store).
1 hall valgus set (Osgood) (Codman and Shurtleff).
1 set wood carver's gauges, 1 in., ½ in., ¼ in., curved on the flat and edge (sample enclosed).

Tools

½ dozen spools 1/16-in. copper wire.
1 bench vise, 4-in. jaw.
1 hack saw extension, 12 blades (Miller's Falls).
2 monkey wrenches, 3-in. opening.
1 machinist's hammer, medium (Maydole).

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1 machinist's hammer, small (Maydole).
1 pair pliers (to bend wire).
1 pair heavy cutting pliers.
1 rivet punch.
1 3-in. screw driver (machinist's).
1 reamer.
1 breast drill and set of Morse twist drills to fit rivets and stove bolts.
1 box ⅛-in. soft iron rivets.
1 box large size copper rivets and burrs.
1 box small size copper rivets and burrs.
1 box brass stove bolts.
2 center punches.
1 cold chisel, ¼ in. wide.
1 cold chisel, ½ in. wide.
1 small, fine mitre saw (12 in.).
½ dozen 6-in. three cornored files.
3 large rat-tail files.
3 small rat-tail files.
3 12-in. metal files (milled).
2 6-in. blade knife file.
1 pair heavy tin shears, straight.
1 pair heavy tin shears, curved on the flat.
1 heavy 3-in. blade tailor shears.
4 6-in. boat builder's clamps.
1 block lead, 2x4x3.
1 oil stove.
1 fine carborundum stone.
1 gross safety pins, Damascus brand (Walker Stetson Co., Lincoln Street, Boston).

April 27 a telegram was received from the medical director of the Red Cross at Washington, asking for the names of twenty orthopedic men between the ages of 30 and 45. Not knowing the exact purpose of the service, your chairman went on to Washington and was in conference with the officials there two days later, taking with him the names of sixty possibly available men. At that time the nature of the service was stated, an appeal having been brought over from England by Colonel Goodwin, a member of the special embassy from England, requesting that twenty men be sent as soon as possible to assist Col. Robert Jones in his special orthopedic hospitals.

Telegrams were sent out at once, and just two weeks later the entire list was complete, and orders were received to rendevous in Washington on the 15th of May, expecting to sail the following day.

At the same time it was requested that your chairman go over with these men to transfer them to Colonel Jones, so that he could know of their special fitness.

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It was also requested that your chairman make a survey of the orthopedic and general reconstruction work which is being carried on in England and France, returning as soon as possible to assist in the establishment and development of similar work.

Besides this, as you know, a very considerable number of our orthopedic men have already started for Europe or are awaiting transportation, these men being part of the base hospital units for service in England or France.

It is quite obvious that the orthopedic profession is meeting its opportunity, and the recognition of the need of such work by the officials in Washington should be a source of much satisfaction to us.

JOEL E. GOLDTHWAIT, Chairman.

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